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PUBLIC WORKS MINISTRY

IRRIGATION REPORT

FOR

THE YEAR 1887

BY

Colonel Sir Colin C. SCOTT MONCRIEFF, K. C. M. G., C. S. I.

Egypt. Irrigation dept.

CAIRO
NATIONAL PRINTING OFFICE
1888.

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ADMINISTRATION REPORT

FOR 1887

1. — From the statistics of expenditure given in appendix A, at the end of this Report, it appears that the outlay connected with the irrigation and drainage of Egypt during last year was as follows :

	L. E.
NEW WORKS : Ordinary Budget	29,798
» Million Grant	342,479
» Special (Nubarieh Canal)	23,453
REPAIRS AND MAINTENANCE : Ordinary Budget	105,804
» » » Corvée Relief Budget	233,561
Works from Corvée Ranson	4,046
Payment to Behera Irrigation Society	53,851
TOOLS AND PLANT : Ordinary	820
» » Million Grant	6,544
TOTAL... L.E.	800,356

But this large sum does not represent all that Egypt spent in these agricultural works during 1887. The table at para : 6 shews that the unpaid Corvée employed in clearing canals and drains was equivalent to a force of 87,120 men for 100 days, and assuming their labour worth only 2 piastres a day each, this represents a sum of L.E. 174,240.

Nor does this Corvée include the army of watchmen on guard during the 2 $^{1}/_{2}$ months of High Nile.

To control this expenditure and direct all these works, an establishment was employed costing :

Ordinary Budget	L.E.	44,054
Million Grant	»	16,758

To this sum perhaps 75 °/₀ of the cost of the Central Administration at the Ministry, or L.E. 25,590 might be added (whole cost of the Ministry, L.E. 34,121). This makes a total of L.E. 86,402, or 10.8 per cent of the money expenditure above.

I shall endeavour in this Report to render an account of how this large sum was spent, and what has been the gain to Egypt.

2. — During the first six months of the year the Nile was favourable, and the supply of water satisfactory. The distinct rise at Assouan did not begin until the 16th June, when the gauge stood at 2 pics 5 kirats, exactly the same gauge as on the same date in 1886. But here the similarity ceased. By the 16th July, the gauge was 7 pics 9 kirats, or a rise of 2.79 metres. On the 16th July 1886, there had only been a rise of 1.48 metres above the lowest. The river stood as high on the 10th August, as the highest point attained in 1886 (on the 22nd September), and for the 47 days following, it exceeded this height. It attained its highest on 1st September, 17 pics 21 kirats. As a separate report has been made of the Nile flood, it need not be described here. It is enough to say that as far as imperfect records shew, only twice within the last 62 years had such a flood as this passed Cairo, viz : in the years 1874 and 1878.

The highest gauge at the Barrage was 18.39 metres above sea level. It does not appear that the gauge ever attained 18 metres before without disastrous breaches in the embankments. In 1887, we were fortunate enough to have none, and the great flood passed out to the sea without seriously injuring Egypt.

3. — Owing to the operations on the Rosetta Branch Barrage, more water than usual was sent down the Damietta Branch. The temporary dams across the river, however, were erected and removed as in 1886. The dam below the heads of the Bahr Moes and Sahel canals was begun on the 15th April, and not entirely finished until the 5th May. 5,024 cubic metres of stone were employed on it, and it cost, to erect and remove, L. E. 1,344, holding up

·44 metres of water. In 1886, only 3,707 cubic metres of stone were employed, and it held up 1.05 metres. The dam below the head of the Mansourieh and Om Salama canals was begun on the 22nd April and finished on 1st May, holding up the water surface to a level of 5.95 metres above the sea, or ·62 metres higher than it would have otherwise stood: a difference, as Major Ross points out, equivalent to an increase of supply of 620,000 cubic metres per diem, or 50 per cent in the Mansourieh canal. In this dam 6,123 cubic metres of stones and bricks were used, and its erection and removal cost L.E. 2,433. In 1886, 6,387 cubic metres of material were used at a cost of L.E. 3,945.

The dam below Damietta to keep the salt water from coming up to the town, was repaired for a length of 400 metres, but most of the work done in 1886 was found uninjured. 12,617 cubic metres of earthwork was done at a cost of L.E. 1,009. It was begun on the 18th May and finished on the 19th June.

4. — The usual dam was placed across the Rosetta Branch downstream of Khatatbeh to hold up the water surface sufficient for the pumps to work. It was begun on the 3rd and finished on the 26th March, and cost L.E. 2,329. In 1887, it cost L.E. 2,609. It held up the water surface on an average, from April to July, 85 centimetres. There is now such a stone bed across the river here, that the cost in future should be very much less.

The great dam at Mehallet-el-Emir to keep out the salt water was begun on 1st February and closed on 17th April, the construction being similar to that of 1886. A heavy storm on 9th April greatly interfered with the work and forced salt water far up the river. The outlay was L.E. 10,649. This is a disappointment, for I had hoped to have made a large economy on the cost of 1886 which was L.E. 11,022. It held up on an average 50 centimetres. This dam must be a yearly expense until we can finally dispense with the Atfeh pumps. That cannot be until we have really put the Rayah Beherah into good order, and until the Barrage holds up to

its full height of 4 metres. Perhaps we may have attained this i
1891.

5. — The cotton crop for the last four years has been a
follows :

1884 — 3,591,500 kantars or 156,150 tons
1885 — 3,039,454 » » 132,150 »
1886 -- 3,116,350 » » 135,500 »
1887 — 2,850,000 » » 123,913 »

The falling off is due, I believe, to the mischief done by th
cotton worm, and to the cold fogs of autumn. It would have bee
greater had it not been for the increase of cotton cultivation i
Beni-Souef and the Fayoum.

6. — The accompanying table shews the numbers employed o
the Corvée, and the sums spent in Corvée Relief in each Provinc
compared with the figures of 1886, also the members employed i
the last year of the old regime 1883. It is so far satisfactory tha
although the relief expenditure in 1887 was 12 °/₀ less than i
1886, still the numbers employed in the Corvée were 8 ¹/₂ per cer
fewer, instead of being, as might have been expected, rather more
But too much stress must not be laid on such figures. No tw
seasons are exactly the same, and the requirements of one greatl
exceed those of another. When the time comes to write the recor
of 1888, it will be seen how much additional labour had to b
called out to repair the damage done by the floods of last year.

PROVINCES	N° OF MEN EMPLOYED CALCULATED FOR A PERIOD OF 100 DAYS		GRANT IN AID OF CORVÉE RELIEF		N° OF MEN EMPLOYED IN 1883 CALCULATED FOR 100 DAYS
	1886	1887	1886	1887	
			L.E.	L.E.	
Kalioubieh	1,363	1,666	25,656	24,319	7,621
Sharkieh	6,924	5,338	24,161	15,969	18,238
Dakahlieh	9,394	10,358	27,679	21,188	20,605
Menufieh	13,398	4,967	44,873	15,610	26,887
Gharbieh	7,025	5,181		24,500	25,093
Behera	6,387	5,573	48,936	24,481	8,172
Ghiseh	995	3,288	12,704	33,744	5,929
Fayum	1,157	3,010	2,606	6,738	6,255
Beni-Souef	4,010	3,090	8,617	7,862	8,217
Minieh	5,851	5,841	10,711	9,289	11,898
Assiout	9,930	8,839	17,608	16,076	25,668
Girgeh	8,223	10,821	18,512	15,625	15,366
Keneh	14,650	13,418	23,003	11,335	18,429
Esneh	5,786	5,730		6,628	4,172
TOTAL	95,093	87,120	265,066	233,561	202,650

Mr Garstin very truly remarks regarding the diminution of Corvée labour:

> The Dakahlieh and Kalioubieh Provinces have made much less progress than Sharkieh in this way, and this is owing chiefly to the inefficiency of our staff in these two Provinces, they being more or less of the ancient Egyptian type. In Sharkieh, on the contrary, we have a most intelligent man in charge, Ahmed effendi Said, who does his best to carry out our views.

As stated in my last year's Report, I have little doubt that it is a good deal for want of intelligent supervision that the Corvée maintains its immense numbers in the southern Provinces. If we compare the Corvée in the seven Provinces of Lower Egypt with what it was in 1883, we see that with an outlay this year of L.E. 126,067, with the partial use of Barrage, and with the many improvements made within the canals since that date, the number employed on the Corvée has been reduced from 106,616 to 27,512 men. Indeed the numbers employed in Menoufieh in 1883 were nearly as many as the whole Corvée of Lower Egypt in 1887.

7. — In my Report for last year I alluded to the unsatisfactory outcome of Messrs Fox and Anderson's dredging contract in the three Eastern Provinces. I am glad to report a great improvement in 1887. After various experiments, the contractors have now got a very satisfactory form of dredger, the sand pump pattern of which eight were employed. Mr Garstin says of it:

> The sand pump is undoubtedly the dredger for our big *Sefi* canals whose beds are either fresh mud or sand deposit. It will not touch either mud or sand that has been deposited for several years and become hard. This only the bucket dredger or the Priestman can be used for. For the purpose of removing the annual deposit in our canals, however, I think it is the best form of dredger that can be found. It ought to do from 500 to 600 metres cube per diem when properly supervised, and where the lift is not too great. For of course the greater the angle of the shoot, the greater the power required to force the stuff up through it.

8. — The dredging done by the Beherah Irrigation Society was not much more satisfactory than it had been in 1886. That is to say, they succeeded perfectly well on the Mahmoudieh canal where there were no difficulties. From the Rayah Behera was removed 522,111 cubic metres of silt with six dredgers, a large quantity but still much less than they should have done, (one powerful dredger N° 20 doing only 354 cubic metres per diem instead of 800 cubic

metres as might have been expected). In the smaller canals where most of all we hoped to have good dredging done, no serious attempt even was made. The dredging in the Eastern Provinces has been then decidedly more satisfactory than in Behera.

9. — In my Report for 1886 I alluded to the new system of paying some of the Corvée for clearing the deep *Sefi* canals which we had hoped to do by dredging. In 1887, this system was followed again, but on two canals only which might have dredged, the Sharkawia and Bassussia.

There were employed on the former 5,929 men for 11 days, on the latter 4,227 men for 20 days. The total quantity of work done was 160,961 cubic metres or 1.08 cubic metres, per man per day. The outlay was L.E. 3,220, or 2 piastres per cubic metre, with a small extra rate for each village sheikh.

A paid Corvée was also employed by Mr Garstin on the Kurtamia, Filfila and Kumbatin canals, the head sluices of which were too small to admit the dredgers. From these, 87,004 cubic metres were dredged at a cost of L.E. 1,740. But I trust we shall have no further recourse to the paid Corvée. The heads of the Kumbatin and Filfila canals have been adapted to let dredgers pass, and in the present year 1888 they are being dredged. The Kurtamia is not a canal that can be dredged, but it can be cleared in December by hand labour.

10. — The class of earthwork contractors is decidedly improving as might be expected. Mr Garstin, I am glad to say, has been more successful than last year with his sheikh contractors. His remarks on the subject are to the point :

> During 1887, I again tried the plan to which I alluded in my Report for 1886, of getting the village sheikhs to take up the work of clearing their own village canals, making them petty contractors in fact.
>
> I only tried this in the Sharkieh Province, where I had failed the previous year. A beginning was made as fifteen sheikhs came forward and cleared

twenty seven canals, the cubes of which amounted to 41,784 metres cube. This is not a very large amount, but it is a beginning, and when one takes into account their suspicious and timid natures, and their reluctance to bind themselves to anything in the shape of a contract, I do not think it was a bad start.

The plan on which I worked was this :

Of course, I know the cubes to be cleared in each canal, I put what I considered a fair rate down for each, which rate varied from 1 1/2 P. T. to 2 P. T. per metre cube. I did not tell the sheikhs what rate I was giving them, but merely told them the total lump sum, which sum I agreed to give them as soon as they had cleared the canals to the satisfaction of the Government Engineers in charge.

They asked for advances at first, but this I refused, and eventually they worked without them. The work was very fairly well done, quite as well as that done by the small European contractor, and one great advantage of this plan is that as each sheikh is only allowed to clear his own village canals, if he does not clear them well, his water supply suffers, but he can only blame himsel ; I an convinced that this system in the future will be the best method of relieving the Corvée, especially as the people are now to be allowed to redeem themselves by payment. The money for the work done will then go back into the hands of the people who have really paid for this work by redeeming themselves.

The great danger is, of course, lest the sheikh gets all the money and does not pay his labourers, making in fact another form of Corvée. To obviate this, I would always keep a certain number of the canals in each district back from the sheikhs and give themselves to European contractors. These last must pay their labourers, and the fellah is becoming quite sharp enough to know that if he goes and works on a certain work that he will be paid for his work. I think then that with paid labour going on close at hand, they will not work for the sheikhs unless they pay them something. Any how the experiment is a very interesting one, and I hope this year to develop it largely.

I may mention that the people of Kalioubia Province have come forward and offered to clear the whole of their canals themselves if I will pay them for their work.

Mr Willcocks writes on this subject as follows :

I did nod try sheikh contractors for the smaller canals. I tried one sheikh on a canal irrigating 3 villages, and had complaints against the clearance through the year, from the other villages, who said they were sacrificed. The sheikh of Sibibai cleared his village canal as usual. I am trying to get sheikh contractors on Mr Garstin's principal, but have not been very successful up to the present. On recommending these works to a couple of sheikhs, whom I know, and who are generally respected, they replied that sheikhs who had taken works had been considered dishonest by the fellaheen when they had worked straight, and that they did not care to lose caste. I have given one contract to the fellaheen of a village, who complained that their sheikh liked keeping the Nile canal badly cleared, and then selling water at a high price from his engine in August. They now have the contract at a lump sum 1 P.T. per cubic metre.

Captain Brown reports that in Minieh and Assiout what prevented omdehs and sheikhs from coming forward to take up contracts, was the system insisted on of submitting every contract to public tender. They are shy of coming forward. Mr Garstin's system quite meets cases like this, and I believe the system will have a large development ere long, and will be found to work well.

11. — The authors of the decree granting L.E. 250,000 annually for the partial abolition of the Corvée have tied it down with restrictions which greatly detract from its value. It often happens that the introduction of a set of regulating sluices enables such a control to be exercised over the water in a canal that silt is no longer deposited and the Corvée no longer necessary to remove it. We have built works of this kind, of which the cost has not exceeded one year's silt clearance. But as masonry works could not be done by the Corvée, we dare not devote any of the L. E. 250,000 to such works, and instead of spending perhaps L.E. 500 once for all, we are obliged to continue spending as much year after year in removing silt. A similar case frequently occurs in Upper Egypt. The long basin embankments are yearly washed away by the lap of the waves and require remaking. Were we allowed to spend any of the L.L. 250,000 in facing such banks with stone, the annual outlay on repairs would be saved. But this we cannot do, and so the yearly need of spending money.

The Corvée Relief decree, in short, is on a par with most of the others which internationalism has devised for the welfare of Egypt.

12. — *Extraordinary grant of one million.* — The year 1887 was one of very marked progress in the execution of extraordinary irrigation works. Of the million pounds granted, L.E. 114,495 had been spent up to the 1st January 1887, and L.E. 343,296 was the expenditure for this year. The great work of the year was the strengthening of the Barrage. The season's compaign began on the 2nd December 1886. The work went on steadily by day until the 28th March, and from that date to the 1st July without intermission by day and night. On the afternoon of the 1st July the last piece of machinery was removed from the bed of the river. Before daylight next morning, the rising flood had covered all that had been done. The work was one of great difficulty and anxiety, and reflects the highest credit on Lieutenant Colonel Western and Mr Reid who directed it. New difficulties presented themselves day after day requiring new expedients to meet them, and the ready invention of the engineers was being perpetually put to the test.

Appendix B contains Mr Reid's report of the work, to which I can add nothing, except my tribute of praise to him and to Lieutenant Colonel Western.

13. — The Rayah Tewfiki or great Trunk canal, starting from the east end of the Barrage was begun early in 1887, and the earthwork from the Barrage to the junction of the Bahr Moes, a distance of 37 kilometres (5,985,000 cubic metres), made good progress. It should be finished by August 1888, but the masonry works are not so advanced, so it cannot be opened before 1889.

The foundations of the head lock and sluices have given trouble, and it has been thought better to change the original design and to found upon masonry wells or cylinders. Much progress was not made during the year in this work. When completed, it will consist of six spans each 5 metres wide, with a lock 50 metres long, with a clear width of 8.5 metres.

The six spans will be in every way similar to those of the adjacent Barrage, so that the gates, lifting gear, etc. will all be interchangeable.

14. — Two irrigation syphons have been built under the Rayah Tewfiki to supply irrigation from the Bassussiah canal on the East to the strip of country between the new canal and the Nile on the West.

The first ot these syphons in kilometre 1 is intended for the irrigation of 3,583 feddans (170,000 cubic metres per diem), and consists of an iron pipe 4 ft. 5 $^1/_2$ inches in diameter.

The second in kilometre 13 is to irrigate 14,305 feddans, and consists of two pipes similar to the first.

15. — The disturbance occasioned by the new Tewfiki canal cutting through the existing system of irrigation necessitated two new regulating bridges on the Filfila and Kumbatin canals which were built during the year.

16. — The Rayah Tewfiki cuts both the Cairo and Zagazig lines of Railway, a short distance East of the Benha station, and swing bridges will be necessary. These are being built by the Railway Administration. They did not make much progress in 1887, but will be ready as soon as they are required. Just north of these bridges, a pipe syphon, 1 metre in diameter, was built under the Rayah Tewfiki to enable the property of H.H. the Princess Fatma Hanem lying to the East of the canal to continue irrigating from the large pumping station on the bank of the Nile.

The Bahr Moes which is now taken directly from the Nile, will be fed in future from the Rayah Tewfiki. A regulating bridge (7 arches of 3 metres), and a lock are required where it leaves the Rayah. The excavation of the foundations was begun during the year. The maximum discharge through this regulator will be 8 $^1/_2$

millions cubic metres. In Low Nile it will be 2,365,000 m^3 per diem.

One other important work on the Rayah Tewfiki was given out to contract in November 1887, but no outlay was incurred. From the Barrage to where this canal joins the Sahel canal of Dakahlieh is 37 kilometres, and from there onwards to the lock and regulating bridge at Mit Ghamr is 28 kilometres. Experience elsewhere in Egypt has shewn that it would not be possible to establish a complete control over the water distribution if we left this long reach of 65 kilometres without a single regulator across the canal. We took some time to arrive at this conclusion, and it was only with the greatest reluctance we did so, for a regulator infers a lock also, and the cost of the two will not be less than L.E. 19,272. The site selected is at Gangara, 1,900 metres below where the Bahr Moes takes off the Rayah. The regulator will consist of 6 arches of 3 metres. It is calculated for a flood discharge of 9,962,000, and a summer discharge of 6,067,000 cubic metres per diem.

The regulating bridge and lock at Mit Ghamr, begun in 1886, stopped in August owing to the failure of the contractor. The regulating bridge was well advanced, but the lock was not begun. It is hoped that all will be finished in 1889.

The swing bridge for the Railway over the Mansuriah canal was partly built and will be ready in 1888.

The tail lock into the Nile at Mansurah made good progress. The masonry was practically finished in November, but the iron work for the lock gates, although delivered, was not erected. The lock should be open for traffic this summer.

The regulator and lock at Kalangil on the Bahr Saghir, where the Faraskurieh canal takes off, made steady progress throughout the year, and will be open for traffic probably in August 1888.

The syphon to pass the water of the Faraskurieh canal under the Ananieh creek, 4 kilometres above Damietta, was completed and opened during the year.

The reservoir to supply Damietta with fresh drinking water during Low Nile was finished.

These complete the list of works in the Provinces East of the Nile necessary for their irrigation when their whole water supply is drawn from above the Barrage.

17. — Coming to the Provinces between the Nile Branches, the lock at the head of the Rayah Menoufieh was vigorously prosecuted during the year. It was a work of unusual difficulty and expense, as it was impossible to close the Rayah during its construction. It was built under Mr Reid's supervision without the intervention of any contractor and was finished in January 1888. It is a lock of great value.

The new lock at the head of the Bagurieh canal was carried on steadily and will be opened in 1888.

The same contractors were entrusted with the lock at Shubrabas, 30 kilometres farther down. But the progress here was not so good owing to the usual difficulty about foundations. About two thirds only of the foundation platform had been laid at the end of the year.

The Railway swing bridge at Dalgamun was not begun in 1887.

The double tail lock into the river at Kudaba should have been far advanced before the end of the year. But very great trouble was experienced with the contractor. The work dragged on very slowly, and a rupture of the Nile embankment during the flood put the whole site under water. The year was lost for this work, and legal proceedings with the contractor are the result.

These complete the works necessary to open up navigation between Cairo and Alexandria, when the Rosetta Branch of the river is drained of its supply diverted into the canals.

One other lock had been begun before the end of 1886 at Santa on the Bahr Shibin, intended to open up navigation to the town of Mehallet-el-Kobra. The same contractor was employed on this work as on those at Mitghamr, and his failure caused the loss of the year.

18. — The Kafr Dawar lock and regulator on the Mahmudieh canal was begun, but much progress was not made in it owing to some difficulties of foundations requiring a change of design.

The Rosetta canal was practically finished in 1886. The outlay in 1887 was on account of land bills and some petty works.

19. — The Feshn syphon under the Ibrahimieh canal in Beni-Souef (N° 24 of this list) was designed last year (see para: 33 of the Report for 1886), but was begun and practically finished in 1887. It will be, I trust, a most useful work, carrying off during Low Nile the drainage of about 75,000 feddans lying to the West of the Ibrahimieh canal, and during High Nile serving as a feeder direct from the river to the Sultani Basin.

20. — In the Fayoum it was resolved to abolish a basin of 12,000 feddans known as the Hod-el-Tuyur, and to supply it with perennial irrigation. There were various good reasons for this measure, not the least being that the annual emptying of this basin into the Birket-el-Kurun caused its waters to rise and swamp many acres of good land. 73 kilometres of minor canals and water courses, and 33 kilometres of drainage cuts were made in connection with this project.

21. — It will be noticed how often have been recorded here the difficulties of foundations. The sudden call to spend a million of money on difficult hydraulic works produced a host of so called contractors. Nearly all were unknown to us. Few had any sort of experience of what they were about to undertake. The subsoil of Egypt varies much in character. Even under the same lock it represents more than one variety of ground, and no ordinary borings could indicate its consistency twenty feet down. The con-

tractors tendered as though certain to find firm earth, and the result has been loss and delay at the head of the Tewfiki canal, at Mitghamr, at Santa, at Shubrabas and at Kafr Dawar. The delay and the waste of money at Kudaba are not due to bad foundations.

22. — I pass on to the works carried out from the Ordinary Budget and from the Corvée Relief funds. Table II, Appendix A, is a list of thirty-four new works added to the irrigation system of Egypt. They cost altogether only L.E. 29,798, a very inadequate sum to spend on this object. They are works of a very unpretending nature, built with the closest attention to economy. But they are all useful and practical, enabling us the better to control the water in the canals and basins, and opening up lines of navigation and drainage.

23. — *Kaliubieh, Sharkieh and Dakahlieh.* — In these three Provinces Mr Garstin has devoted the money at his disposal, either to building regulators and sluices the better to control the water distribution on his canals, or to improvements in drainage. The drainage lines were not generally quite new, but were long neglected lines cleared out, widened and deepened, and the money spent on them came generally from the Corvée Relief fund, they being essentially works on which the Corvée used formerly to be employed. The following is Mr Garstin's list for the year.

Sharkieh Province.

(a) Towehr drain. 8,000 metres long cost L.E. 2,248, including syphon under canal Mit Rideni (L.E. 1,000 defrayed from the Million, see N° 27, Table I, Appendix A).

(b) Um Shok drain. 3,000 metres long cost L.E. 218.

(c) Bahr Harami. 5,000 metres long cost L.E. 911.

(d) Bahr-el-Bagar. 110,000 metres weed clearance cost L.E. 352, and dredging cost L.E. 777.

(e) Bahr Battikh. 7,500 metres. This was commenced in November 1887, but the cost will come into the account of 1888.

(f) Project for Wadi Tumilat drainage.

Dakahlieh Province.

(g) Nizam drain. 32,000 metres expended in 1887 LE.. 6,294, including new syphon under Shon canal.

(h) Tanah Gabbadah drain. 18,000 metres long. Annual clearance L.E. 1,284.

(k) Bashmùr drain. 35,000 metres long, annual clearance and alterations to Bagallat and Kirwan aqueducts, cost L.E. 1,496.

(l) Sirwa drain. 11,000 metres extension cost L.E. 3,047.

24. — The Towehr drain, begun in 1886, is now finished.

The Um Shok drain is a prolongation of the Arin drain and consists of turning a canal into a drain, a measure asked for by the people.

The Bahr Harami is an old line deepened and cleared. It benefits the land about Tawila and tails into the Bahr-el-Bagar, but it must be continued upwards for about 3,000 metres.

Mention was made in para: 39 of last year's Report of the great drain of Eastern Sharkieh known as the Bahr-el-Bagar. A Priestman's dredger has been working in it since 1886, but the sand is so hard that little progress is made, while the weeds grow up as fast as they are cut down. The water surface is lower than it was in 1885, but the drain so far is not a success, and will require a large outlay before it can be made a success.

The Bahr Battikh is a branch of the Bahr-el-Bagar. Its progress had been long checked by the obstruction of a certain sheikh Abdallah. At last Mr Garstin induced him to give in, and the drain is a very useful one.

The survey for the long proposed Wadi Tumilat drainage was completed. It will cost L.E. 22,000, and is calculated to reclaim

27,000 feddans. Whenever the wakf, to whom it belongs, grants the money it will be put in hand.

The Nizam drain, begun last year, should have been completed in 1887. Unfortunately, the task was given to an incompetent contractor who tendered too low a rate, and failed in his engagement. The State Domains who advanced L.E. 7,000 for the execution of this drain have lost a season by this misadventure. Mr Garstin says :

> The work must now be given to another contractor to finish, and will cost more than if it had been given at first at a fair price to a good man.

25. — These lines are all main arteries, and in many cases, to have full effect, require a system of side branches. It is hardly possible that Government can assume the burden of making all these local drains. But there seems little chance of the people doing them for themselves. They strenuously object to a drain passing through their lands at all, even though they themselves will benefit by it as well as the landowners further from the outfall.

26. — Among other useful works of the year, Mr Garstin mentions the widening of the Wadi canal, begun in 1886 and nearly finished in 1887, 83,240 cubic metres having been removed at a cost of L.E. 3,745. This canal has been furnished too with new supply sluices from the Ismailieh canal (see N° 3, Table II, Appendix A) which will greatly assist the irrigation of Sharkieh. The banks of the Ismailieh canal were raised from kilometres 37 to 52, at a cost of L.E. 963. This enables an additional metre of depth to be held up at the Bilbeis lock, and so less water will be allowed to escape into Lake Timsah.

27. — We were disappointed again in our hopes of seriously reducing the dredging in the Ismailieh canal. In 1886, 369,918 cubic metres were removed. In 1887, 340,153 cubic metres.

The Menayar junction which supplies water from the Sharkawieh to the Ismailieh during High Nile was put in order for the first time in 1887, and Mr Garstin is hopeful of a considerable reduction of silt deposit in consequence.

28. — A useful little project was prepared for supplying irrigation to 2,000 feddans of desert land close to Suez. It was to cost only L.E. 1,800, but want of funds prevented its execution.

29. — The following table of the irrigation in the Eastern Provinces is of interest.

	WATER CONSUMED Millions cubic metres per diem			Flood Cultivation	Sefi Cultivation	Winter Cultivation
	FLOOD	SEFI	WINTER	— Feddans	— Feddans	— Feddans
Kaliubieh.........	5.3	0.6	1.6	180,000	25,000	140,000
Ismailieh canal....	1.0	2.5	2.5	3,000	2,000	2,000
Sharkieh..........	14.5	2.2	5.5	355,000	140,000	430,269
Dakahlieh.........	17.7	4.65	8.1	450,399	150,133	300,266
	38.5	9.95	17.7	988,399	317,133	873,535

Major Ross remarks:

> If all these canals were dredged truly, their discharge would not be less than 10.5 millions of cubic metres, but owing to defective dredging and defective bed widths, I think Mr Garstin has 10 millions. His figure is 9,950,000, a very close approximation. (1)

30. — *Menoufieh and Gharbieh.* The Melig regulator and lock were practically finished in 1886. The Lstg. 930 spent this year (N° 7 of Table II) was the price of land occupied. The

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(1) Since writing the above Mr Garstin has carefully measured the discharges of his canals, which he found in June 1888 to amount to 10,184,600 cubic metres per diem, Major Ross' estimate is therefore very accurate.

work was first brought into use during the floods of 1887, and proved of the greatest value, enabling us to hold water up to the level required for the irrigation of Menoufieh without flooding Gharbieh with more than was required.

31. — The works for controlling the Bahr Saidi, begun in 1886 (see para: 30 of my Report for that year), were finished in 1887, in all respects, except the erection of the lock gates. Once they are erected, there will be during High Nile free navigation from the river for about 40 kilometres to the Lake Borillos, and thence by the Beltin canal through the Salahib lock to Mehallet-el-Kobra. As it is, the control so much desired has been established over the water supply, and while in ordinary years, above 17 millions of cubic metres used to be daily poured into the Lake Borillos, during the extreme flood of 1887, Mr Willcocks kept down the volume to 3,200,000 cubic metres.

The Salahib lock and regulator on the Bahr Tira was finished except for the lock gates. It was not then available for navigation, but served to regulate the floods in High Nile.

32. — The Bahr Tira itself was prolonged 12 kilometres to Beltin, giving, for the first time for many years, sweet drinking water to this remote town of 3,500 people, and irrigating the date groves around it. This canal cuts right across Lake Borillos, and the portion to the East known as Little Borillos is now protected from salt water, and may be cultivated. Mr Willcocks has another idea, of storing water in a large reservoir on this ground, with which rice irrigation could be given in summer to the adjacent country.

33. — A regulator was built at the head of the Ashmun Escape, Nagar canal (Menoufieh), for L.E. 990. This work enables the canal to be scoured of silt without the usual clearance, and was therefore charged to the Corvée Relief fund.

Mr Willcocks spent L.E. 300 on an iron pipe to convey irrigation water during High Nile under the Bagurieh canal, at Kafr Rabia (Menoufieh), to irrigate the lands on its right from the Sirsawieh canal on its left. The villagers paid for the whole cost of erecting this syphon. L.E. 776 were spent in stone pitching below the Nashart and Karnain regulators, L.E. 410 in iron aqueducts to take flood irrigation across the new Mitbera junction canal, L.E. 200 in similar aqueducts over the Bahr Saidi. The ordinary repairs to regulators cost L.E. 1,282 in Menoufieh, and L.E. 1,047 in Gharbieh, sums which Mr Willcocks thinks insufficient to keep the works in repair.

34. — The total quantities of earthwork done by Corvée and contract during the year was as follows:

	SEFI CANALS — cubic metres	NILI CANALS — cubic metres	REPAIRS OF NILE BANKS — cubic metres	DRAINS — cubic metres	TOTAL — cubic metres
Menoufieh	105,945	741,322	111,489	39,907	998,663
Gharbieh	899,065	159,019	136,789	428,800	1,623,673
TOTAL...	1,005,010	900,341	248,278	468.707	2,622,336

35. — The following table gives the areas cultivated and the water consumed:

	WATER CONSUMED Millions of cubic metres per diem			Flood Cultivation — Feddans	Sefi Cultivation — Feddans	Winter Cultivation — Feddans
	FLOOD	SEFI	WINTER			
Menoufieh	28	9.875	12	257,065	82,392	288,800
Gharbieh				450,000	355,000	734,000
TOTAL...	28	9.875	12	707,065	437,392	1,02,2800

36. — On the subject of giving water on the canals by rotation or *manaubas*, Mr Willcocks writes as follows:

> In summer there was a general system of *manaubas* through the two provinces. Notices were posted up in the Mudiriehs in April, and from 1st May all the canals were closed at the head by an earthen bank for 7 days, and kept running for 14 days.
>
> Not an acre of cotton was lost anywhere, nor of rice. Indeed on their own account the Sheikhs of the Western Berea came to me in May and told me if it was possible on the new Bahr Saidi system to give some canals full flush supply one week and nothing the other, they infinitely preferred it to perpetual lift supply. Now their crops were almost entirely rice. The Leséfer and Sanhur canals ran this alternate supply through the summer, and the Leséfer irrigated practically nothing but rice.

37. — *Behera and Giseh.* Mention has been made in para: 18 of the work done at the Kafr Dawar lock and on the Rosetta canal. Besides these, works Nos 12 to 17, Table II, Appendix A, were carried out in 1887. They are all minor works with the exception of N° 17.

38. — An opportunity occurred in summer for thoroughly overhauling the regulating bridge and lock at the head of the Rayah Behera.

The work consists of three regulating arches of 4 metres span, and a lock on the right side 8 metres wide and 30 metres long between the gate recesses (The lock has never been supplied with gates). Its total length is 55 metres. The lock and bridge floorings were inverts, the lowest point being at a reduced level of 9.10 above the sea. The flooring extended 3.5 metres upstream of the pier heads and 8.50 m. downstream of the piers (altogether 25.80 metres).

Mr Foster found the floorings well built and sound, and the arches and lockwalls in good condition, but the wingwalls beyond the flooring up and downstream seem to have been built on the most insecure and shallow foundations. When the water pressure was removed from them, they at once shewed signs of settlement. Want of time prevented Mr Foster doing anything to the upstream wing-walls, but he placed an upper stratum over the whole of the flooring, thus raising its surface to reduced level 10, and he extended the flooring downstream for a distance of 14 metres, thoroughly supporting and propping up the unsound left revetment. The right revetment downstream of the lock also bulged forward when the work was laid dry. Mr Foster protected it by throwing in a large quantity of stone along the front. The lock he left untouched except that for a distance of 5.70 metres, at the upper end he raised the floor to reduced level 10.00. It will be seen that this work is not yet in a satisfactory state. Some day sluice and lock gates must be supplied to it, and then the good work begun by Mr Foster may be finished.

39. — The principal object of solicitude in Behera is always the water supply. In no Province of Egypt is there more outcry made if water fails. In no Province is so little done to assist the Government, the reason being that here more than elsewhere the land is in the hands of wealthy proprietors, many of them foreigners, who have stronger ideas about their supposed rights than about their duties.

Behera receives rather more water during Low Nile in proportion to its area than any other Province in Egypt, and this water is all pumped from the river at a heavy cost. It has been therefore our first object to place in working order its proper source of supply, the Rayah Behera. Our efforts have hitherto had little success. In last year's Report, I described our failure, and said that after the floods, in spite of our narrowing the bed by groynes or spurs, the sand deposit had increased. In para : 8 I have mentioned the unsatisfactory dredging done by the Behera Irrigation Society in this canal. The amount dredged by them was 522,911 cubic metres at a cost of L. E. 17,640.

At first it was hoped to be able to dredge a channel on a uniform slope right through the sand deposit, but when in May it became necessary to close the canal, the dredging of course stopped, and work was carried on by hand labour. This amounted to 131,000 metres. It was not done by the Society in the way desired, and the rapid rise of the Nile put a stop to the experiment. The sum to be paid for this hand clearance formed the subject of dispute with the Society which was not finished until the beginning of this year when L. E. 4,039 was paid to them, a sum which was considered to represent the practical value of their work.

40. — In para : 51 of last year's report I mentioned what was being tried on the Rayah Beherah to stop the erosion of banks, and create a scour in the middle of the canal by a system of groynes or spurs projecting from the banks. This experiment deserves fuller notice.

In 1886 Mr Foster had not sufficient material to carry out all we could have wished, and the canal was too shallow during Low Nile to allow of our boating stones along it. He erected that year:

13 stone spurs between kilometres 12 to 14
35 timber spurs » » 15 to 21
42 sand-bag spurs » » 17 to 27
40 brick spurs » » 27 to 31.

Experience shewed that only stone and brick spurs answered. The sand bag spurs probably would have answered, but it was impossible to keep the bags from being stolen. Mr Foster says they were carried off literally by thousands by the Bedouins and inhabitants of neighbouring villages. The timber was also stolen in quantities. The outlay that year was L.E. 6,205.

In 1887 Mr Foster tried the effect of spurs made of unburnt bricks with their heads of burnt bricks, and substituted these for the timber and sand-bag spurs that had practically disappeared between kilometres 15 and 26. The experiment might have succeeded, had not the Nile flood burst into the canal, and flowed over the top of the spurs. The unburnt bricks could not stand the water flow, and only the burnt brick ends were left.

Altogether 189 spurs, some of them 20 metres long, were made in 1887, at a cost of L.E. 8,033.

They were placed opposite each other, 200 metres apart where the canal is straight, at 60 metres apart on the outside, and 100 metres on the inside of curves. The distance across the canal between spur heads was fixed at 44 metres, allowing for a bed width of 20 metres, and side slopes of 2 to 1 on a depth of 6 metres.

Our experiments on cheap spurs have not then succeeded. But the principle is clearly sound, and should be carried on for the next few years. We may be confident that expensive as it is, it well lead to much future economy in dredging.

41. — In order to promote the formation of firm banks, willow trees were planted along the edge of the Rayàh Behera àt high water mark from kilom. 10 to 36. These hàve succeeded well on the left bànk. On the right, they are interfered with by dredging. Further to check the sand drift from the desert, screens were erected for a length of 18.9 kilometres to the West of the Railway and pàrallel to it at a distance of 18 metres from the outside rail. They were from 2 to 2 ½ metres high, made of cotton stalks, set vertically and kept in place by horizontal slips of wood. They cost P.E. 4.5 per running metre, and half of the expense was borne by the Railway Administration. These screens have answered well.

42. — In para: 53 of last year's Report, mention was made of the effort to supply irrigation to the strip of country between the Ràyah Behera and the desert, with the view not only of reclaiming land once fertile till conquered by the desert, but also of overlaying the drifting sand with more stable soil and herbage.

This experiment was continued in 1887, and a considerable volume of muddy water was discharged over this tract during High Nile. Banks for a length of 2,480 metres were run up, costing L.E. 3079, and an active growth of herbage has resulted.

43. — Owing to the failure of the Rayah Behera, the Province drew its supply entirely from the pumps at Atfeh and Khatatbeh which worked well throughout the season.

The following table gives the volumes supplied:

	Commenced pumping	Finished pumping	Days working	Mean daily discharge — cubic metres
Atfeh...........	3rd December 86.	6th August 87...	246	1,746,000
Khatatbeh......	1st » »	29th July »...	241	1,845,146

During the months of June and July, the Atfeh pumps furnished a daily average ot 2,382,500, and the Khatatbeh of 2,390,000 cubic metres. By contract the Atfeh pumps are not supposed to furnish more than 2 millions of metres a day, but the Behera Irrigation Society agreed to supply what was required above that quantity at the rate of L.E. 42 per million cubic metres instead of the regular charge of L.E. 28.

44. — This volume of water is enough for the Province if properly utilized, but Behera has never furnished anything approaching its quota of men for the Corvée, and the privileged classes who are allowed to redeem their men by a money payment, fulfil the first part but rarely the last part of this engagement. For instance, in the Abu Homos district, the largest in Behera, the whole number turned out for the Corvée is 35, and no ransom money is paid by the proprietors to furnish contract labour. The result is that no

proper clearance of the canals of this district has been done since 1884.

45. — The season when Behera really requires more water than she now has, is as the Nile rises in August. There is then always a great demand for cotton and rice irrigation, while the cultivator is anxious to begin his *durra* crop. In other Provinces, the volume of the canals is increased four fold during the first month of the river's rise. In Behera, the only difference is that water is obtainable without the cost of pumping, but the volume itself is little increased. Major Ross has been closely studying this question, and has, I trust, found a solution for it in the construction of a new feeder to the Khatatbeh canal, just north of the Railway crossing. This work is being carried out during the current year 1888.

46. — For the last two years, Mr Foster has been systematically improving the Mahmudieh canal, so as to reduce the silt deposit and annual cost of dredging. A uniform slope is gradually being given to the canal from Atfeh onwards to Alexandria. The bed is only dredged now to a width of 15 metres from Atfeh to the 45th kilometre where the Kafr Dawar lock is being built, and to a width of 12 metres onwards to Alexandria. The banks are slowly being improved, but so valuable is the stuff dredged that the neighbouring proprietors are glad to secure it for their fields, and it is difficult to keep it for the banks.

The improvement of the heads of canals and private water courses taking from the Mahmudieh is gradually going on, proper sluices with regulating apparatus being fitted by degrees to all.

47.— In para : 36 has been mentioned how Mr Willcocks succeeded in giving water by rotation to different people and so eking out a scanty supply. It has been quite necessary to apply this system in Behera, but it has met with hot opposition from landowners who in former days scrambled for the water as best they could, regardless of the claims of their poorer neighbours. In Behera, this rotation system is peculiarly necessary owing to the length of the canals. The Abudiab, for instance, is about 80 kilometres long, and 58 steam pumps have been allowed to be erected along it. A similar difficulty arose on the branches of the Ferhash canal which is 49 kilometres long and on the lower portion of the Pasha canal. On the 5th June, Mr Foster began to give water by rotation six days closed and six days running. The measure was fairly successful. On the Mahmudieh canal there are 26 steam pumps with an aggregate 278 H. P. Mr Foster writes of this:

> To close all the sluices a contractor was employed. It was with considerable reluctance, I accepted this method, but it proved successful. No complaints of dishonesty or oppression were received. The work might have been done by gangs of men under the Engineers, but the draw back to this was that the Engineers had other works to perform, and therefore would not give up sufficient time to supervise it properly. A regular contract was made with the man and he was subjected to heavy penalties. L.E. 15 per closure on the whole length of canal was paid, the total sum expended having been L.E. 210.

48. — The important regulating works at Kafr Boolin (kilometre 83 of the Khatatbeh canal) were put into thorough working order this year, as far as it was possible to do so, without drying the canal.

These works consist of:

(*a*) A regulating bridge across the Khatatbeh canal itself.

(*b*) An escape into the Nile.

(*c*) The head sluices of the Aminagha canal.

(*d*) An old sluice on the left bank, downstream of (*c*) and upstream of (*a*).

The escape had been restored in 1884.

The main regulator was in a very ruinous state, but is now in good order. The head sluices of the Aminagha canal now form the head of the Nubarieh canal. It consists of two openings of 3 metres each and can discharge a volume of 2,750,000 cubic metres per diem at High Nile. The old sluice (*d*) belonged to a *Nili* canal known as the Masraf Kafr Boolin. This canal has now been connected with the Abudiab, the head of which was in the bank of the Khatatbeh canal 5 kilometres downstream. The sluice has been altered into a single opening of 4 metres. So now the head ot Abudiab canal is above the regulator, and thereby about 70 centimetres in water level is gained. The old canal has been deepened and widened out to a bed width of 5 metres, so as to carry 1.5 millions cubic metres per diem at High Nile. Altogether there was an outlay of L. E. 1,890 on Kafr Boolin bridges, of which L. E. 510 is chargeable to the Nubarieh canal estimate. The enlarging of the old Masraf Kafr Boolin cost L.E. 2,654, chargeable to the Corvée Relief Budget.

49. — Mr Foster spent L.E. 3,419 in improving the drainage of Behera. The *Masraf-el-Amum* is now in good working order for a length of 42 kilometres from near Damanhour to Lake Mareotis. Its bed varies from 2 to 8 metres in width, and it discharged last October 750,000 cubic metres per diem, chiefly washings from rice fields. As branches are being added to this trunk line, it will evidently require to be enlarged. During 1887, the Sharaishera drain was cleaned out for a distance of 20 kilometres and tailed into the main drain.

Very much remains to be done for the drainage of Behera, and if once we had got the Rayah Behera in proper working order, we might spend a much larger sum on this vital subject.

50. — One other very important work was begun this year in Behera, the Nubarieh canal. The origin of this canal is due to H. E. Nubar Pasha who knew that there was a large tract of good soil, to the south of the Province, only requiring water to reclaim it from the desert. Grants of this land were given to a syndicate of gentlemen under condition of paying the land tax after a period of years, and they agreed together to pay for the construction of the canal. The leader of the syndicate, the enlightened

Sir Constantine Zervudacchi, K.C.M.G. of Alexandria agreed to advance the necessary funds. The preliminary surveys had been made in 1885, and in 1886 the line was roughly laid down. At the end of February 1887 work was begun. It has been work of every considerable difficulty as the country traversed is desert, and it has been necessary to carry the necessaries of life for the work people from a long distance. There have been consequently great troubles with the contractors, in spite of which the earthwork will not exceed P. E. 2 $^1/_2$ per cubic metre in price.

For 3 kilometres from the head regulator at Kafr Boolin, the Nubarieh canal follows the old Aminagha canal which has been enlarged. Beyond that point it is entirely new, and as it passes through desert remote from villages, it has been difficult for the contractors to retain the services of the 2,000 to 3,000 labourers required. Water was obtained from indifferent wells along the line. The undulations of the ground rendered the alignment difficult, and the difficulty was enhanced by the mischief of Bedouins who removed pegs and bench marks.

The Nubarieh canal has been proposed to be 81 $^1/_2$ kilometres in length (including the 3 at the head formerly Aminagha canal). It terminates in the immediate vicinity of Lake Mareotis.

The bed is being dug from 10 to 3 metres wide, with a depth of water from 4 to 3 metres. The estimated cost down to kilometres 81 $^1/_2$ is about L.E. 70,000, of which L. E. 23,453 were spent in the course of the year. In spite of all difficulties the average cost of earthwork does not exceed P.E. 2 $^1/_2$ per metre cube. The area irrigable is about 180,000 feddans, so the cost will be about P. E. 40 per feddan. By the end of September water was admitted for the upper 33 kilometres, and irrigation should regularly begin next High Nile.

For the present it will only be possible to give this canal water during High Nile. After the Barrage is restored and the Rayah Behera put in order, it may be possible to give it water in *Sefi.*

The rapidity with which the work has been done reflects the greatest credit on the veteran Engineer Labib Bey who has been from the first entrusted with its execution. Mr Foster has recently proposed the extension of the Nubarieh canal for 22,·5 kilometres further which will bring it within a distance of 10 miles from the sea at Mex, but this project remains to be considered.

51. — *Fayoum.* In para: 20, mention has been made of the abolition of the Tuyur basin. The effect of this work, and of the other works carried out by Mr Hewat with the view of economizing the water supply in the Fayoum, have been very satisfactory as regards the lowering of the water surface in the Birket-el-Kurun.

On inspection last October, I found the edge of the lake had receded 650 metres from the place where Mr Foster fixed his water gauge opposite Sannoris only as lately as 1885.

The following table shews the progress of reducing the water surface in the Birket-el-Kurun. The lake is at its lowest in October and at its highest in March.

	WATER SURFACE BELOW SEA LEVEL.	
	Minimum — October	Maximum — March
1885	41.50	40.56
1886	41.80	40.76
1887	42.05	41.16
1888	.....	41.50

Mr Hewat reports that this reduction of water level has dried from 8,000 to 10,000 feddans of land round the lake. It will be remarked that while the water surface rose from October 1885 to March 1886, 74 centimetres, the rise, from October 1887 to

March 1888, was only 45 centimetres, due chiefly to the abolition of the Tuyur basin.

52. — Repairs were made to Lahun regulating bridge and L.E. 630 were spent in a spur directing the course of the water below, where there is a hole in the bed of 18 metres in depth. Mr Hewat bestows great pains in improving and repairing the numerous scattered masonry works of the Province. These are all small works, but are none the less important. He spent in this way L.E. 801 during 1887.

The Batn Haret canal was enlarged and lengthened for 5 kilometres to irrigate 2.000 acres of new cultivation. This cost only L.E. 305.

The drying of the Tamiyah tank (or *Khazàn*) is going on steadily. Its area is 800 feddans, and about 2,000 feddans more are included in the neighbouring marshes of Roda, Forkis and Zirbi. About 400 feddans are now reclaimed and the whole will soon follow, it is to be hoped.

53. — The water supply in the Fayoum was steady throughout the year. Cotton cultivation is making very rapid strides, and backward and neglected as the Fayoum was so long, the improvements of the last few years are very marked.

Appendix C gives a note by Major Ross on improvements in the Fayoum.

54. — *Girgeh, Assiout, Minieh, and Beni Souef.* The Low Nile was a favourable one for the Ibrahimieh canal. The gauge on the bridge at Assiout reached its minimum of 45.26 on the 13th May. Two days after, Captain Brown had a measurement made of the water entering the canal and found it (the gauge being 45.28) 4,434,005 cubic metres per diem, but he believes that really more was entering, and throughout the season there never was any want of water.

It was arranged that one fourth of the volume at Deirut should be passed on to the Fayoum, and that Province never received less than 1.5 millions of cubic metres per diem, but in future it will probably establish claims to one third of the available discharge.

55. — The areas under crops depending on the Ibrahimieh canal in May and June are reported as follows:

	Feddans
Assiout	31,000
Minieh	101,000
Beni-Souef	45,000
Fayoum	52,000
Total	229,000

Since 1884, the sugar cane cultivation has increased by about 34 °/₀, and in Beni Souef Province there has been a good beginning of cotton cultivation, indicating the satisfactory water supply in the Ibrahimieh canal.

56. — As stated in former Reports, the chief source of expense on the Ibrahimieh canal is dredging. The following figures shew the progress made in reducing it.

	CUBIC METRES DREDGED			EXPENSE
	ASSIOUT TO DEIRUT	BELOW DEIRUT	TOTAL	L.E.
1884	818,430	330,268	1,147,690	34,656
1885	604,598	182,314	786,912	35,662
1886	461,363	...	461,363	24,429
1887	523,410	...	523,410	26,124

Of the sum shewn here as spent in 1886, L.E. 3,676 were not actually paid until 1887, and of that shewn for 1887, L.E. 2,355 were not actually paid until 1888. The contract with Messrs Du Port and Jones finished at the end of the season 1887. The new contract made since is much more favourable to the Government. If the old contract was too high, it was, I believe, as low as it would have been possible to make in 1884, and Messrs Du Port and Jones have honourably fulfilled their terms in a way by no means universal among contractors in Egypt.

57. — In former Reports it has been shewn how dredging is no longer required in the Ibrahimieh canal, north of Deirut, and in the Report for 1886, it was stated that to diminish the dredging south of this point, Captain Brown had been narrowing the bed of the canal by placing in it a series of stone groynes or spurs as already described in the Rayah Behera. He erected 12 pairs of these groynes in 1886 at a cost of L.E. 2,108. In 1887 he erected 14 pairs, and repaired former ones at a cost of L.E. 2,403. The result has been very satisfactory. The heavy dredging formerly necessary north of Manfalout will probably not be required again, and when the spurs are erected along all the portions requiring dredging, we may hope to reduce it to a very small volume.

58. — These stone spurs are useful in another way. The Railway between Deirut and Assiout is carried along the bank of the Ibrahimieh canal. The flood velocity has year after year cut away the banks and seriously endangered the line. As the Railway Administration is only indirectly under the orders of the Government, a question arose as to the responsibility of maintaining the embankment, which has only been settled after three years discussion. For a considerable distance, the line of Railway will be retired, and the stone spurs will prevent further erosion.

The history of this dispute shews forcibly how the interests of the State suffer from the peculiar Administration of the State Railway.

59. — In 1883, great importance was attached to the fact that the Ibrahimieh canal had cut off from their direct source of supply in the Nile the long chain of basins to its west leading from Assiout to Koshesha, a distance of about 260 kilometres, and that these basins were either fed by the Bahr Yusuf, which had lost a good deal of its fertilizing mud or still worse, only one from the other, so that towards the northern end they received almost clear water. Year by year this evil has been diminished. The great Koshesha basin has now for three years received its water supply direct from the Nile through the Abu Khadiga bank and at its South-East corner be the Magnuna canal direct from the river. These measures have greatly enriched the lands of this basin. The Bahabshin basin next it to the South will soon, it is to be hoped, draw the Nile water direct through the Selim Pasha syphon, the feeding canal only requires to be enlarged. The Nuera basin next to the Bahabshin received its water for the first time in 1887 direct from the Ibrahimieh canal by the new Kolussi canal, and the effect of mud deposit produced has been very marked. Next to the Nuera comes the Nina basin, which since 1884 has drawn its supply direct from the river by the Nina syphon.

Next to the Nina basin comes the large Sultani basin (32,000 feddans) which as already said (para : 19) will in future be fed through the Feshn syphon.

Going further South, Captain Brown is hopeful of arranging for filling the Bardanuha Garnusi basin, in Minieh, through a syphon under the Ibrahimieh canal at Abu Bakara discovered by him last year. The very existence of this syphon was unknown, as it was completely buried under the earthen banks of the canal. Captain Brown has had it dug out and put in order and finds it a work of 7 semi-circular arches of 3 metres span on piers 2.50 metres high, (see N° 27, Table II, Appendix A). It will be readily adapted to pass off drainage water into the Nile in the same way as the Feshn syphon, but before the basins can be fed through it, an expensive feeder canal must be excavated.

Still further South, the Tanashawi basin was fed, for the first time in 1887 direct from the Ibrahimieh, through the long disused Subaka canal. A new bank was placed across the south end of this basin which will in future prevent its being filled at all from the South. It will be filled henceforth from the Subaka canal and Bahr Yusuf.

The Ashmunin basin was fed for the first time from the Deirutieh canal by the new sluices at Kolobba.

60. — In Table II, Appendix A, N°s 22 to 30, are the new masonry works carried out under Captain Brown's supervision in 1887. The Sharahna regulator (N° 22) is built on the Ibrahimieh canal just downstream of the Feshn syphon. There are distributary sluices right and left above it, and a short distance upstream the Abadieh Escape into the river. These works give complete control over the water that enters the Beni Souef Province.

The Edkak canal (N° 26) has now been prolonged from Abu-el-Wakf to opposite Maghagha, a distance of 11 kilometres, and has been tailed into the Gindiyah canal.

Eight culverts from the Ibrahimieh canal and an escape sluice have been fitted with regulating planks and grooves. New head channels were dug for the Selim Pasha and Magnuna canals, the old heads having silted up and being badly placed. Of this, Captain Brown writes:

> This alteration enabled the abandonment of many miles of useless canal which is now being given back to cultivation, while at the same time a large saving will be effected in clearance.

In Beni Souef and Minieh nearly all the bridges have now been put into good repair.

In Assiout three regulating bridges in the river bank of basin Zenar, and a fourth in the embankment, between the town and the hill, were put into thorough order, and fitted with grooves and planks.

The Zenar basin now draws its water direct from the Nile instead of from the Sohagieh canal, after passing through the Beni Simia basin.

In Girgeh nine old bridges were similarly repaired.

61. — Owing to the excessive Nile flood of 1887, there was no difficulty about irrigating the basins, but precautions had to be taken to prevent overflooding, and many canals had to be closed with stones to prevent the water entering them. Captain Brown does not find it easy to work the large Sohagieh canal properly. A large volume must be admitted in order to give the requisite high water surface, and it is difficult to dispose of all this water. Major Ross and he strongly advocate a regularly built masonry escape back into the Nile from the Beni Simia basin, but this will be an expensive work for which we may not be able to provide funds. The Koshesha basin stood at the high surface level of 27.36 m. fed directly from the Nile. This breached the embankment, separating it from the large Bahabshin basin in the South, and these two became one basin. Such a level as this could only be maintained in years of extraordinary flood, unless a permanent escape were built at Abu Kadiga. This is a work of very great importance, the design for which is now being prepared by Colonel Western. Means must be found of carrying it out within the next year or two.

62. — The basins began to be filled on the 10th August. They were emptied during October with the greatest regularity, and in spite of the high flood in the river, they were fit for their sowings as early as in any other year, while the operation of filling sent no flood wave down to Lower Egypt. This control of the water is very creditable to Captain Brown.

63. — Major Ross, after his winter tour in January 1888, wrote as follows:

> The state of Captain Brown's Said district, *i. e.* from Balianah to Assiout, is most encouraging. Everywhere a marked improvement meets the eye. The banks are nearly all bettered in their slope, the Corvée works to lines and slopes. The bridges are in repair instead of standing *sick* with earthen dams across them. Quarrying is everywhere executed. The regulation is done with horizontals. The borrow-pits are regularized and kept at a distance from the works, and the new earthworks are regular and European in pattern.

64. — *Keneh and Esneh.* — These two southern Provinces are lamentably backward. Of course, their remoteness from Head Quarters has much to do with this, but the principal reason, I believe to be the want of an English Inspector with sound engineering knowledge, and force enough to insist on improvements being carried out in face of opposition. The present Inspector, Abu Sand Bey, is a very good man of his class, but he has neither the tehcnical knowledge, nor the initiatory power, nor the position to carry his way

Nevertheless more is being done here than formerly, and Major Ross' careful yearly inspection has borne good fruit.

65. — N^os^ 31 to 34 of Table II are the new works carried out in these Provinces.

N° 31 is a regulating bridge to serve as an escape on the Maallah series of basins about 14 miles South of Luxor, opposite Armant. It was begun and completed before the rise of the Nile when it proved very useful.

N° 32 is a similar escape into the Nile just above Keneh, from the Gebelau Basin on the Shansurieh series. The whole estimate is L.E. 1,937, of which L.E. 465 were spent last year in the collection of materials. It is being finished this year. This work is sure to be of high value and will greatly reduce the silt deposits in the Shansurieh canal.

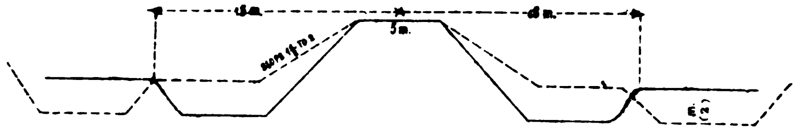
N° 33 is a very important syphon on the Rinnan canal, and I am sorry to say the work of the year was a failure. As I have already stated with reference to the new works in Lower Egypt, the great difficulty in Egyptian construction is laying foundations, and competent contractors are not easily had. The foundations of this syphon passing under a canal had necessarily to go deep. To pump them dry and lay concrete proved too much for Abu Saùd Bey and his contractor, and the season was lost. L.E. 643 were spent on the collection of materials. The work will be finished, I trust, this year.

The Kelh regulator and escape (N° 34), described in last year's Report, was finished in 1887, and was of the greatest service during the High Nile.

66. — Major Ross writes as follows of one of the great difficulties of Engineering in these southern Provinces:

> In the matter of stone supply, the Said is wonderfully behind the world. Cut stone is almost unknown. Pitching is generally picked up from the boulders fallen from the cliffs, and a stone of 400 lbs. weight literally cannot be furnished. The stones used in pitching are too light, and 200 lbs. stones are very rare. The pitching below bridges consequently moves, and it is found better to grout it. There is a capital place for a quarry at Gebelen where beautiful stone exists at the very water's edge, and yet contractors, rather than quarry on a system, bite projections off the hill. A contract given to a proper contractor to quarry on a system would lower the price to probably P. E. 20 from P. E. 30 or 35 per metre cube.

67 — I have already called attention to the immense Corvée still employed in these southern Provinces. One reason for this pointed out by Major Ross is that the native Engineers have not had the initiative or firmness to insist on a change of section of the basin embankments.



The old and vicious profile common throughout Egypt is represented roughly by the black lines in the accompanying sketch. The dotted lines give Major Ross' section. In the former it will be noticed the borrow pit, (Arabic: *Matrabah*) from which the bank is repaired, is directly under a slope often steeper than 45°, not often easier. Into this borrow pit year after year the earth returns. In Major Ross' section the slopes are flatter (though perhaps not yet flat enough) and the borrow pit is some distance off. There is much less chance of this bank losing shape, but to alter from the old profile to this, requires first of all the additional labour of filling in the old borrow pit, and also it requires the landowner to part with a piece of his field which he has not been accustomed to do hitherto.

Captain Brown has resolutely carried through this change. Abu Saûd Bey is not strong enough, but it must be done, and afterwards, little by little, we may protect the exposed faces by stone pitching.

68. — In Keneh, L.E. 837, and in Esneh L.E. 478 were spent on the repairs of sixteen bridges which represents material progress. In former days these works were allowed to fall to utter decay. L.E. 624 were spent on loose stone protection at the heads of six canals in Keneh.

69. — *Protection against inundation by the Nile.* — As a full report on the Nile flood has been already published, this subject will be treated briefly here.

The outlay on this head during 1887 (see Table IV, Appendix A) was L.E. 48,826, and considering the very exceptional Nile flood with which we had to deal, this was, I think, a very low sum. L.E. 2,530 of the amount was, on account of special measures, required to protect the city of Cairo and Boulak during the height of the flood. The expenditure during the last few years has been as follows :

1884	L. E.	58,000
1885	»	61,535
1886	»	44,341
1887	»	48,826

70. — Captain Brown reports favourably of the state of the river throughout his four Provinces, but it was still necessary to add protective works at the three most critical points.

His figures are as follows :

NAME OF PROVINCE	PLACE	1886		1887	
		STONES USED	COST	STONES USED	COST
		C. M.	L.E.	C. M.	L.B.
Assiout...........	Mangabad	3,484	657	2,587	496
»	Nazali	1,733	(1) 45	1,451	229
Beni-Souef.........	Wasta	10,766	1,099	5,535	459
TOTAL...		15,983	1,801	9,573	1,184

Both at Mangabad and Nazali, Captain Brown now reports that there are signs of the force of the current swinging towards the East and away from the exposed face. At Wasta too the heavy spurs erected during the last few years have done their work, and the channel of the river is moving towards the East. There are three other places where protective works were formerly necessary, but are so no longer, viz:

Immediately South of Minieh.
Immediately North of Samalut.
North of Beni Mazar.

---

(1) Cost of placing stones only.

The following figures shew the expenditure in connection with the opening left in the embankment of the Koshesha basin at Abu Kadiga.

	1886		1887	
	CUBIC METRES	COST	CUBIC METRES	COST
		L.E		L.E.
Earthwork	35,307	1,236	40,888	1,401
Stonework	3,963	815	4,794	1,001
TOTAL COST...		2,051		2,410

This outlay is rather on the increase, and every year that a permanent masonry work is delayed, it will become more difficult. The subject is therefore receiving serious study this year as already stated in para: 61.

71. — In Giseh, Mr Foster erected a spur at Kodayah on the east band (1,012 cubic metres of stone costing L.E. 121) and remarks that three or four more will be required here to protect the village. Two were added to the three spurs already built at Nezlet-el-Eyan also on the east bank where Mr Foster says:

> The erosion extends a length of nearly 4 kilometres. The spurs have been very effective in the length of the bank they protect, no further eating away having occurred in 1887. This was the worst place in the Circle.

A heavy groyne was erected on the west bank a little north of the town of Giseh (2,000 cubic metres of stone costing L.E. 420), the effect of this is doubtful.

72. — In Behera, 10 new spurs or groynes were made, and 23 old ones were repaired at a total cost of L.E. 1,477. Of the former, two were at Halkil Gamal north of Atfeh, five small ones at

Shamasma south of Rosetta, and three small spurs in front of Rosetta itself. Mr. Foster reports :

> Abu Khawi is the only erosion which gives any trouble, not because there is much danger, but on account of the complaints of the inhabitants of the village.

73. — Mr. Willcocks spent only L.E. 620 in the repairs to the spurs of Menoufieh and Garbieh, a sum which is too small. He reports that a good deal is required between Kafr-Zayat and Dessouk on the Rosetta Branch, and between Daharia and Kafr Batik on the Damietta Branch. In spite of all short comings, however he staved off an unusual flood in very complete fashion.

74. — In the three eastern Provinces Mr. Garstin reports 34 new spurs built, and 34 old ones repaired. This involved an outlay of 6,581 cubic metres of bricks, 12,827 cubic metres of stone and 2,092 cubic metres of earthwork, costing altogether L.E. 6,433.

Near the mouth of the river below Damietta the action of the waves is very destructive of the bank, and there is both a canal and a military road to protect. Mr. Garstin writes :

> In 1887 we decided to try a system of short spurs each at such a distance from the next as to protect the line of bank between the two. Twenty spurs in all were made on this principle, and it has succeeded excellently well. The cutting of the bank has stopped, and a foreshore is gradually being silted up between the spurs. Of course this is an expensive method of protection, and could not be well employed on any great length of bank, but in a place like the above where it was absolutely necessary to stop the river from eating into the canal, it was worth the expense.

75. — Major Ross continued through the year to devote much study to the survey of the country. He has now finished a useful map of Dakahlieh (saving a small piece of Menzaleh,) and the part of Sharkieh north of the Bahr Moes was surveyed and levelled as well as a strip on the north of Kaliubieh. After the floods a survey

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IRRIGATION REPORT

FOR

THE YEAR 1888

BY

COLONEL SIR COLIN C. SCOTT MONCRIEFF, K. C. M. G., C. S. I.

CAIRO
NATIONAL PRINTING OFFICE
1889.

Mohamed Bey Sabri	Chief	Engineer,	Ismailiah canal.	
Ahmed effendi Said	»	»	Sharkieh.	
Mohamed Bey Zahir	»	»	Menoufieh.	
Mohamed Bey Talaat	»	»	Garbieh, 1st section.	
Aly Bey Borhan	»	»	Behera.	
Abdul Wahab Bey Zeki	»	»	Rayah Behera.	
Mahmud Bey Talaat	»	»	Giseh.	
Mussa effendi Ghalib	»	»	Fayoum.	
Mohamed effendi Neghib	»	»	Minieh.	
Aly effendi Badr	»	»	Assiout.	
Abdul Fattah bey	»	»	Girgeh.	
Ismail effendi Sirri	Assist	Engineer,	1st	Circle.
Hassan effendi Raghib	»	»	»	»
Ali effendi Massaood	»	»	»	»
Hussein effendi Wassif	»	»	»	»
Ahmed effendi Hilmi	»	»	»	»
Ali effendi Taleb	»	»	»	»
Ibrahim effendi Sabri	»	»	»	»
Mahmud effendi Fahmi	»	»	2nd	Circle
» effendi Mungi	»	»	»	»
» effendi Mohib	»	»	»	»
Ahmed effendi Husni	»	»	»	»
Ibrahim effendi Rifaat	»	»	3rd	Circle.
Abdul Magid effendi Farid	»	»	»	»
Hassan effendi Rassim	»	»	»	»
Ahmed effendi Hamdi	»	»	»	»
Ali effendi Shauki	»	»	»	»
Mohamed effendi Zohdi	»	»	»	»
Mahmoud Rifki	»	»	»	»
Abdulla effendi Wahbi	»	»	4th	Circle.
Ibrahim effendi Halim	»	»	»	»
Yussuf effendi Sidki	»	»	»	»
Abdel Rahman effendi Wahbi	»	»	»	»

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REPORT

of the Administration of the Department of Irrigation for the year 1888.

1. — The following table gives the total expenditure of the year compared with that of 1887. The details will be found in appendix A.

	SPENT 1888	SPENT 1887
	L.E.	L.E.
NEW WORKS: Ordinary Budget	25,156	29,798
» Million Grant	346,908	342,479
» Special (Nubarieh Canal)	45,965	23,453
REPAIRS AND MAINTENANCE: Ordinary Budget	117,918	105,804
» » » Corvée Relief	249,846	233,561
» » » Corvée Ransom Fund	74.050	4,046
Payment for water pumped by Behera Irrigation Society	61,255	53,851
TOOLS AND PLANT: Ordinary	662	820
» » Million Grant	5,990	6,544
TOTAL..... L. E.	927,749	800,356
ESTABLISHMENT: Ordinary Budget	48,525	44,054
» Million Grant	16,155	16,758
Add 75 0/0 of Central Administration	31,156	25,590
Total Establishment.... L.E.	95,836	86,402

The Establishment charges are therefore 10.3 per cent of the money expended on works. In 1887, the percentage was 10.8.

The excess this year in the cost of maintenance both on the ordinary Budget and the Fund for Corvée Relief is chiefly on account of the mischief done in 1887 by the very high Nile floods. The large sum received as Corvée ransom is balanced by the smaller number of men called out to forced labour, but the number of the latter is still too great.

2. — For the first half of the year the supply of the water in the Nile was normal, but the heat in June and July was excessive, and the demand for irrigation was consequently very great. The rise of the river was felt at the Barrage in the 23rd June which enabled us to send more water down the Damietta Branch and to relieve the pressure in the Eastern Provinces. The following table is of interest, and shews the regularity of the state of the river year after year compared with any other large river I know of in the world. When the water's surface at Assouan stands below two pics it may be considered as Low Nile.

YEAR	ASSOUAN GAUGE					RHODA GAUGE	
	Fell below 2 pics	Lowest point attained		Rose above 2 pics	Number of days below 2 pics	River attained 16 pics	
		Pics	Kir.				
1884	never	2	6	always	...	13th Aug.	1 pic = 24 kirats
1885	15th April	..	18	27th June	73	3rd »	» = .54 metre
1886	9 »	1	11	13th »	65	15th »	» = 1 ft 9 ¼ inch.
1887	6 »	1	12	30th May	54	4th »	
1888	27 »	1	10	21st June	55	16th »	

When the river has attained 16 pics at Rhoda the flood is supposed to have reached the delta, and the ceremony of opening the Khalig el Masri or Cairo Canal takes place.

3. — As the flood of 1887 had been one of the highest on record, so that of 1888 was with one exception (1877) the lowest of this century. The water surface never rose above 14 pics 16 kirats at Assouan, or above 18 pics 14 kirats at Rhoda where it was 2.59 metres lower than in 1887. This was disastrous for much of the crops of Upper Egypt, and injurious in the Delta. In the former there is an area reported exceeding 300,000 feddans over which the water did not flow, and which have therefore remained out of culture this last winter or what is called *Sharaki*. It is satisfactory to

know that this area would have been much greater, but for the measures carried out under the direction of Lieut. Col. Ross during the last three years, and the vigorous action of Mr. Willcocks who accompanied the Minister of Public Works in a tour to Upper Egypt in September, and took such active steps as to save a large area in Girgeh from barrenness. Mr. Willcocks' report on the subject will be found in the appendix C.

4. — Throughout this year it was on the Barrage at the head of the Damietta Branch that work was carried on. Consequently a less supply was sent down it and the Eastern Provinces on its rights bank had less water than usual. By enforcing a system of rotation however Mr. Garstin secured the cotton crop from any actual loss.

5. — The usual temporary dams on the Damietta Branch below the heads of the Sahel canal and Bahr Moes, below that of the Mansurieh canal and North of the town of Damietta were made and removed. The first of these has been made yearly since 1885, the others since 1886. I hope that this year (1889) will be the last in which they will be required, and I shall be glad of it: for not only are they expensive, but their effect on the river bed year after year is not good.

The net cost of the dam North of Benha was L. E. 1,602, of that North of Mïtghamr L. E. 4 030. North of Damietta only L. E. 136 was spent in repairing the earthen dam of 1887. This was remarkable considering the force of the flood of 1887. It was not intended to close the river, but merely to narrow its mouth and so produce an outward current. But Mr. Garstin reports that so little water was sent down that it only succeeded very partially and the salt water penetrated as for as the village of Zarka, 30 kilometres above Damietta. As regards this Mr. Garstin states that.

> The engines on the Nile bank had to pump brackish water for a time. Wherever this was done, although the rice was killed, the cotton as regards both the quality and out-turn was better than it was anywhere else.

IRRIGATION BRANCH — EXPENDITURE FOR 1887 (*continued*).

N°	DESCRIPTION OF WORK	TOTAL spent on each work	TOTAL in Province	TOTAL in Circle of Irrigation
		L. E.	L. E.	L. E.
	II.— Ordinary Budget — Original Works.			
	Sharkieh :			
1	Three Regulators — Samana Canal...........	992		
2	Ganabieh Salhieh Regulator — materials collected.	232		
3	New Head — Wadi Canal....................	10,00		
4	Earthwork — Towehr Drain.................	12,48		
			3,470	
	Dakahlieh :			
5	Nizam syphon, Shon Canal..................	1,850		
6	Alterations — Mit Abu Ali Regulator..........	674		
			2,524	
	Menoufieh :			5.994
7	Completion of Melig Regulator and Lock........	930		
			930	
	Gharbieh :			
8	Salahib Lock and Regulator..................	2,173		
9	Bahr Saidi — Head Lock and Regulator........	2,561		
10	Kantaret Usman Lock	2,032		
11	Esbet Zeni Lock	17		
			6,783	
	Behera :			7,713
12	Mehallet Bishr culvert......................	377		
13	Sahranieh Head Sluice......................	436		
14	Farhashi »	328		
15	Kilometre Pillars	74		
16	Three Inspection huts......................	425		
			1,640	
	Giseh :			
17	Strenghening Regulator Rayah Behera	2,488		
			2,488	
	Fayoum :			4,128
18	Head Sluices............................	494		
19	Matul Weirs	240		
20	Protective Works Lahoun....................	890		
21	Dam in Bahr Yusuf.......................	23		
			1,647	
				1,647
	Carried forward.....	....	....	19,482

8. — A further extension this year was made in Corvée abolition, by the permission accorded after much discusion to the whole corvéable population of certain Provinces to redeem themselves. It was an experiment and was confined to the Provinces of Sharkieh, Menoufieh, Gharbieh, Giseh, Beni-Souef, Minieh, and Assiout. The districts of Gafarieh, Zifta and Mehallet el Roh in Gharbieh were exempted, and furnished Corvée as usual. The ransom sum was fixed at P.E. 40 per head generally throughout Lower Egypt and for lands on the Ibrahimieh canal, P.E. 20 in the rice districts, P.E. 30 in Upper Egypt generally. It was not until February that the measure was sanctioned when Corvée work was already begun, and in progress. The difficulty at once arose as to who were the corvéable. The old census of Mohammed Ali was entirely out of date. The census of 1882 was not relied on. Some moudirs like that of Beni-Souef gave up in despair and not a man in the Province ransomed himself. In Minieh things were hardly better. While the active and intelligent Moudir of Assiout found 59,000 men willing to pay ransom.

9. — The accompanying table gives the statistics of Corvée labour, etc. The numbers shewn as redeemed in the Province of Dakahlieh does not quite represent the case. Corvée redemption in general was not allowed in this Province, but the State Domains have always exercised this right as regards their peasantry, and the sum here recorded is what was due for former years as well as 1888. It is satisfactory so far to know that while in 1883 there were 202,650 men employed for 100 days on forced labour, the number in 1888 was only 58,788 men. Mr. Garstin notes that about one quarter of the whole work done in Dakahlieh viz : 209,799 cubic metres of earthwork consisted of strengthening the Nile embankments rendered necessary by the injuries done during the flood of 1887. The same remark holds good for Giseh, and generally throughout Upper Egypt. In some Provinces indeed and notably in Girgeh so much labour was bestowed

MUDIRIEHS	Nº of Corvée for 100 days	Nº who ransomed themselves	Nº of Corvée employed in 1883 100 days	WORK done by Corvée	WORK done by contract Corvée Relief Fund	WORK done contract by Corvée Rans. Fund	TOTAL WORK done by contract	TOTAL WORK done Corvée & contract	Sum spent of Corvée Relief	Sum of Corvée Ransom	TOTAL SPENT
	Number	Number	Number	Cubic Metres	Cubic Metres	Cubic Metres	Cubic Metres	Cubic Metres	L. E.	L. E.	L. E.
Kaliubieh....	1,538	...	7,621	204,919	445,764	...	445,764	650,683	15,070	75	15,145
Sharkieh-....	...	29,986	18,238	...	643.502	579,598	1,223,100	1,223,100	22,000	11,964	33,964
Dakahlieh....	6,633	28,950	20,605	968,733	941,804	339,592	1,281.396	2,250,129	23,133	9,234	32,367
Menoufieh....	...	51,337	26,887	...	447,192	875,987	1,323,179	1.323,179	18,111	12,493	30,604
Gharbieh. ...	2,804	19,328	25,093	270,537	1,638,671	810,535	2,449,186	2,719,723	26,136	14,942	41,078
Behera.......	3.508	192	8,172	354,072	664,036	1,500	665,586	1,019,658	20,826	248	21,074
Giseh........	1,538	21,667	5,929	290,546	690,715	478,579	1,169,294	1,459,840	37,464	6,484	43,948
Fayoum	1,807	...	6,255	226,643	462,293	...	462,293	688,936	7,244	58	7,302
Beni-Souef....	3,397	...	8,217	640,256	520,390	...	520,390	1,169,646	8,000	...	8,000
Minieh.......	5,567	3,766	11,878	1,163,160	806,618	115,814	922,432	2,085,592	10,000	1,129	11,129
Assiout......	4,636	59,038	25,668	1,119,617	1,015,571	1,190,324	2,205,895	3,325,512	16,326	17,423	33,749
Girgeh.......	13,620	...	15,366	1,973,555	1,103,447	...	1,103,447	3,077,002	16,000	...	16,000
Keneh, Esneh.	13,740	...	22,601	1,672,262	2,073,561	...	2,073,561	3,745,823	27,461	...	27,461
Barrage......	...	...	...	...	...	...	...	...	2,075	...	2,075
TOTAL...	58.788	214,264	202,650	8,893,300	11,453,594	4.391,929	15,845,523	21,738.823	249.845	74.059	323.595

on strengthening embankments that the clearance of canals was neglected, from which serious results occurred when the Nile flood failed.

10. — Among the peasant proprietors of Lower Egypt the Corvée Redemption has been very popular, and large numbers have readily paid. It is not so among the large proprietors and owners of *Esbehs*. Many of these are Europeans, and they look on themselves generally as a privileged class who are entitled to all the State can give them without rendering the slightest service in return. Mr. Willcocks calculates that while the numbers who paid ransom money per 100 feddans were among the *fellahin* of Menoufieh at the rate of seventeen men and in Gharbieh of seven men, the holders of *Esbehs* paid in Menoufieh only for two men per 100 feddans and in Gharbieh for two men for 500 feddans. This glaring evil we must hope will be rectified ere very long.

11. — The dredging done by Messrs. Fox and Anderson in the three Eastern Provinces was on the whole satisfactory. It amounted to 637,599 cubic metres against 802,795 done in 1887, but as 206,812 cubic metres dredged in 1887 were not paid for until 1888, they appear in financial accounts as belonging to the latter year. Of course it would be more satisfactory if such a large quantity were not required, but clearance done by dredging instead of hand labour is generally a gain.

In Beherah, Mr. Foster reports that for the first time the dredging was done in a satisfactory manner by the Beherah Irrigation Society. The volume dredged in the Rayah Beherah and Khatatbeh canals was 563,745 cubic metres, against 522,111 in 1887. On the smaller canals of Beherah, 41,978 cubic metres were dredged. This was the first year dredgers were ever at work on these last.

IRRIGATION BRANCH — EXPENDITURE FOR 1887 (*continued*).

NAME OF WORK	OUTLAY	TOTAL
	L.E.	L.E.
VI. — Expenditure on Corvée Ransom Funds.		
Dakahlieh :		
Siala Drainage Works-Bahr Saghir	630	
Enlargement Nizam Drain	1,444	2,074
Menoufieh :		
Iron pipe aqueducts, Mitbera Canal	411	
Drainage syphon, Kafr Rabie	295	
Repairs to Regulators	411	1,117
Gharbieh :		
Irrigation pipes, Bahr Saidi	197	
Repairs Nashart Regulator	575	772
Fayoum :		
Petty Works	85	85
	TOTAL... L E.	4,048

VII. — Payment to Behera Irrigation Society.

FOR THE SUPPLY OF WATER IN THAT PROVINCE:

	L.E.	L.E.
Fixed annual sum	26,320	
Supply of water at Atfeh	10,073	
» » Khatatbeh	17,458	53,851
	Total.....	53,851

APPENDIX B.

BARRAGE REPAIRS

REPORT ON WORKING SEASON 1887

It having been decided to commence the work of repairing the Barrage by strengthening the floor of the left half of the Rosetta Bridge, the enclosure of that part of the structure within earthen dams was begun on December 2nd 1886. The dams were double, the outer dam having been intended to act in case of the inner one slipping. As the orders of the Public Works Ministry were to the effect that the water surface of the Barrage should be maintained at R.L. 13.00, if possible, and should never except under pressure of threatened accident fall below R. L. 12.80, the crests of these upstream dams were kept to an uniform level of 14.50. They were constructed in water varying in depth from 1 $^1/_2$ metres near the shore to 5 metres in the middle of the river

The downstream dams were brought to the level of 12.50 as the surface of the water was at R. L. 12.00 when they were made, and fell steadily to its summer level of 10 in April.

The dams were constructed in two months without any difficulty. The gates of the left half of the Barrage having been shut so as to reduce the flow of the water over the area to be enclosed, the two banks upstream and parallel to the Barrage were run forward for about 8 metres, by end-lipping Bowles Portable Railway and Rolling Stock being used. At this point, the current, setting diagonally towards the open half of the Barrage, and the draw caused by the leakage through the shutting of the closed half, prevented further progress being made in this manner. The completion of the outer dam was then pushed forward. At the end of the completed portion of the dam, a boat bridge 40 metres long was got into place, and a similar bridge was made 20 metres from the point at which the dam changed its direction and turned to meet the Barrage. These two bridges were finished with a plank roadway 12 metres wide, and the bed of the river below them, and for 20 metres downstream was floored with sand bags to prevent deepening by scour. The portions of the dam between the ends of the two boat bridges and between the outer bridge and the Barrage were brought to water surface by dropping sand bags along the alignment of its inner edge and backing with earth tipped from boats.

The regulating brige for the Bahia canal at Mitghamr had been built in 1887. That for the Mansurieh canal was completed in 1888, and the adjoining lock had its foundations laid. At Mansurah the swing bridge for the railway over the Mansurieh canal was finished, as was the great tail lock into the Nile which was opened by H. E. Mohamed Zeki Pasha, Minister of Public Works, on the 6th July. This work has cost altogether L. E. 26,327.

The lock and regulating bridge at Kalangil on the Bahr Saghir were finished, but not opened until the beginning of 1889. They have cost altogether L. E. 17,480.

16. — Between the two branches of the Nile the lock at the head of the Rayah Menoufieh was finished in 1887, and the canal itself was closed from the 1st December to 20th January 1888 to allow of the lock being opened to traffic. It has cost altogether L. E. 15,222 and is of great value allowing of good navigation at all times between Cairo and the centre of the delta.

The lock at the head of the Bagurieh canal was finished and opened during the year. Its cost has been L.E. 12,963. The lock at Shubrabas on the same canal as reported last year gave much trouble. About two thirds of the foundations had been laid in 1887. In 1888 the rest was finished and the side walls were built up to 2.50 metres above floor.

The Dalgamoun swing bridge under the railway is being carried out under that Administration. It was not begun during 1888.

The incompetency of the contractor employed on the Kodaba tail lock connecting the Bagurieh canal with the river and the consequent legal proceedings occasioned the loss of a whole year, during which nothing was done.

The lock and railway swing bridge of Santah had been begun before the end of 1886, but the contractor failed. It was taken up again at the beginning of 1888, and the swing bridge was finished and opened for traffic. The lock foundations gave much trouble, but a considerable portion was done before the Nile floodstopped the work.

and the wall above which was 8 metres high cracked badly and lent over out of plumb.

By the evening it became apparent that further pumping would probably result in the fall of the lockwall, and the water was therefore allowed to rise 2 metres. At that height the springs ceased to throw mud, and owing to this and to the pressure of the water on the soil outside the foundations, a certain amount of stability was obtained and time thus gained for further work.

When pumping was discontinued, the ground had been cleared for the upstream apron for its full width of 25 metres and for a length of 30 metres.

About half this area had been covered with rubble masonry to an average thickness of 1 metre.

Concrete composed of 5 parts of broken stone, 1 $^1/_2$ parts of desert sand, and 1 part of Portland cement, was then substituted for rubble masonry.

It was laid by tipping and treading down the tiphead. After two weeks when the water was pumped down, the work was dug into and found to have well set.

The laying of the remainder of the apron gave no trouble. Springs occurred at a good many points, but they did not threaten the safety of the structure and they were all satisfactorily closed. Where the soil was of sand the lower part of the apron was built of rubble masonry in mortar composed of 1 $^1/_2$ of homra to 1 of lime.

Where the soil was bad the whole was made of rubble stone laid in mortar composed of 2 of sand to 1 of cement.

Concurrently with the laying of the apron, the repairs and additions to the existing floor were carried on. A great deal of difficulty was met with, owing to the ruinous state of the foundations of the bridge and to the tangled mass of rubbish of all sorts with which its floor was buried to the depth of 3 metres. The cofferdam, enclosing arches n^{os} 46 to 55 inclusive, had partly tumbled down. It had been originally very strongly constructed and largely braced with iron rods. These had bent and were interlaced with timber, stones, chains, and every conceivable form of debris. The removal of almost every timber of this cofferdam was followed by a squirt of water through the floor, and during its removal and the building of the new floor, the bridge itself cracked badly, evidence of considerable settlement.

The floors of the arches were raised to heights varying with the condition in which they were found to be. N^o 53, which was the worst of all, was raised to R.L. 11.50. The springs under this arch were numerous and prevented the water being got down below 2 metres above floor. They were closed by the aid of iron pipes. The floor having been cleared of debris, silt, and rubbish as far as possible, ordinary cast iron pump pipes 6 feet long were put into place, one vertically over each spring, and concrete was tipped to water surface round them and over the whole area of the floor. Whilst this was being done, the water coming through the pipes was led away to the pumps in troughs and by channels previously prepared. When the concrete had set for six days, a trench 1 metre wide and extending from pier to pier was dug through the concrete down to floor level, a site having been chosen which was as far as could be judged sound. The floor was thoroughly cleaned and the trench was then filled in with concrete laid in layers and rammed. The object of this was to make a water tight diaphragm extend from the old to the new floor, and thus to prevent creep of water between the two. The pipes were then filled with finely broken concrete metal and closed by $^{1}/_{4}$ inch iron plates bolted on to their flanges, india rubber packing rings being used to make the joint tight. The whole floor was then concreted over to the necessary height and the Ashlar face laid.

One 12 inch, one 10 inch and two 4 $^{1}/_{2}$ inch pipes were used in closing the springs coming through the floor of this arch, and although all precaution was adopted the arches cracked considerably during the progress of the work.

Arches N^{os} 52 and 54 were also troublesome, the floor downstream of N° 54 being broken across diagonally in two separate lines — One of these lines was a crack for half its length widening out into a fissure 4 inches wide for a length of about 4^{ms}.

Where cracks of this sort occurred, they were staunched as follows: The broken floor was cleared of debris bit by bit and covered at once with sand to a depth sufficient to keep down the springs. It was then surrounded at a distance by concrete laid after thorough clearing on the sound floor and carried up to a level at which the springs could not break through it. The concrete was then pushed on inwards until it was stopped by the flow of water. When this occurred the sand was carried away as deep as possible, and rubble masonry laid in cement mortar was built on the sand, a trench about 5 m. wide being left coinciding with the crack in the floor. Concrete metal was laid a few inches deep, and on it a pipe 2 m^{s} longer than the crack closed at one end and perforated with $^{1}/_{2}$ inch holes along its under half circumference for so much of its length as coincided with the crack was securely built into the new masonry for its imperforate length.

An outflow drain was left in the masonry in the prolongation of the pipe, and the water from the broken floor thus was passed through the pipe to the pumps. When the masonry had set, the pipe was covered in with masonry laid in cement gauged neat, and the whole then raised to a safe height. The end of the pipe was afterwards closed with an iron plate and the outflow channel built up.

Upstream of arch N° 51 and between its cutwaters no floor appeared to have been built as no trace of it could be found at 1.5 metres below its proper level.

The floor downstream of the Barrage was found to terminate at the distance of 12 metres from the bridge in a row of piling. Such drawings of the work as exist show a talus of concrete extending downstream of this piling but in one or two [illegible] of it be found. The piling itself for almost its whole length projected from. 5 to 1. 25 metres above the floor and along its line numerous springs existed. The piles were all sawed off to the level of the floor and covered with rubble masonry 1 1/4 metres thick, this masonry being carried downstream to a distance of nowhere less than 7 m^{s}.

Downstream of arches N^{os} 48, 49 and 50, the floor was extended to a distance of 22 metres beyond the piling, and downstream of arches 51, 52, 53, 54 and 55 it was carried to a distance of 30 metres.

The left upstream lock was protected for its whole upstream length by an apron of rubble masonry 1 metre thick sloping from R. L. 12.00 at the wall down to R. L. 10.00 at a distance of 12 ms, a toe 2 metres wide and 1 metre deep being given to the whole length.

Parallel to the Barrage and at a distance of 20 metres from the upstream edge of its existing floor, a row of sheet piling was driven for a depth of 5 metres, the new floor being carried over it for a width of 5 metres.

Cast iron grooves in which the new drop sluice gates will work were fitted to arches.

The repairs to the floors of arches n^{os} 33 to 61 inclusive were completed by July 1st, on which date work was stopped by the rise of the river.

In all 5,221 cubic metres of concrete, 12,985 cubic metres of rubble masonry, 412 cubic metres of Trieste stone Ashlar, and 1,491 cubic metres of Tura stone Ashlar were laid. 133.6 cubic metres of piling were also driven.

The total expenditure on the work was L. E. 81.333.

The unwatering was done by six 12 inch contrifugal pumps, two 10incg centrifugals, and one 9 inch pulsometer. An arrangement of a 4 inch pulsometer mounted on a truck with boiler and flexible suction was found to be very useful inunwatering small areas.

The work was carried on during the day without holidays from December 2nd 1886 to March 28th 1887. From the latter date to July 1st it was prosecuted without intermission. The lighting employed was electric, 8 arc lamps of 2000 candles power each being employed.

(Signed) A. G. REID.

Mr. Garstin has further spent L. E. 1,301 on the improvement of roads along his canal banks which are now in many places fit for general traffic.

21. — The following is given by Mr. Garstin as the length of canals and drains in the Eastern Provinces. Had the canals been originally laid out on any scientific system the irrigation might have been effected with a much smaller number.

PROVINCE OR LOCALITY	SEFI CANALS — Kilometres	NILI CANALS — Kilometres	DRAINS — Kilometres	TOTAL GOVERNMENT CHANNELS — Kilometres
Kaliubieh............	145	522	...	667
Ismailieh canal........	276	. .	...	276
Sharkieh............	1,762	352	152	2,266
Dakahlieh............	1,258	410	324	1,992
TOTAL....	3,441	1,284	476	5,201

Mr. Garstin estimated that during the *Sefi* of 1888 each feddan of land required in Sharkieh 19.14, and in Dakahlieh 17.68 cubic metres of water.

The following canal and river discharges measured about the 18th June are of interest, the gauges up and downstream of the Damietta Branch Barrage being 12.93, and 11.55.

Ismailieh canal.........	2,559,017	cubic	metres	per diem.
Sharkawieh canal......	634,693	»	»	»
Bassussieh canal.......	322,234	»	»	»
Bahr Moes canal......	1,729,036	»	»	»
Sahel canal	1,973,203	»	»	»
Mansurieh canal	1,635,552	»	»	»
Um Salama canal......	1,330,344	»	»	»
Total discharge irrigating three Eastern Provinces...	18,184,080	»	»	»
Discharge of river at Mansourah	7,800,000	»	»	»

APPENDIX C.

Note on Irrigation improvements in the Fayum by Major J. C. Ross C. M. G. Inspector General of Irrigation.

When Sir C. Scott Moncrieff wrote his Note on the works to be constructed in Egypt, and for which the million was sanctioned, the Fayum was put down at L. E. 120,000. Nothing practically was known about the Fayum except that it was curiously behind all the other Mudireyahs even under native rule.

2). Mr Foster, when the Fayum was under him, made several reconnaissances and studies which resulted in Mr Hewat's receiving a memo: from him in which the following were the chief points :
A. Dam at kilo 12–14 Bahr Yusuf to give additional security to Lahun Bank primarily, and secondarily to give more certain supply to the canals between 10 and 17 kilometre Bahr Yusuf.

B. — Establishment of great drainage channels which he proposed to form (1) by abandoning the large canal of supply, the Nezlah, and turning it into a drain, connecting it with the Wadi-el-Minya, and (2) by abandoning irrigation from, and carriage of water for irrigation by the Ravine known as the Bats el Tamiyah.

C. — Changes at the tail of the Bahr Yusuf which were to be effected by prolonging the main channel of the Bahr Yusuf, and there forming a new pond from which the canals would branch off.

D. — Abolition of the Basin system in the Province by changing the Hod-el Tuyûr into Sefi and thereby largely diminishing the supply of water passing into the Birket-el-Qârûn, thus stopping the annual incremental rise of the water which had since the opening of the Ibrahimyah canal submerged about 12,000 feddans.

E. — Reclamation of various desert tracts conceded to proprietors under the decree of 1884.

F. — Gradual conversion of the ravine canals into drains and alignment of the irrigation system on the ridges.

24. — The total quantity of earthwork done in maintenance of canals and drains during 1888 was as follows :

PROVINCE	SYSTEM OF WORK	SEFI CANALS — Cubic metres	NILI CANALS — Cubic metres	REPAIRS OF NILI BANKS — Cubic metres	DRAINS — Cubic metres	TOTAL — Cubic metres	SUM SPENT
							L. E.
Menoufieh	Contract	258,471	909,791	154,917	...	1,323,179	25,448
»	Corvée	...	...	...	...	...	...
Gharbieh..	Contract	514,250	221,590	598,000	1,115,346	2,449,186	44,518
»	Corvée	111,086	159,451	...	...	270,537	...
TOTAL...	...	883,807	1,290,832	752,917	1,115,346	4,042,902	69,966

From this table it is shewn that in these two Provinces only 6.69 per cent of the work was done by forced labour, and that 27 per cent of the whole was devoted to the maintenance of drains.

25. — The "Sadds" or closure embankments across the tails of the canals in Gharbieh to prevent the water running to waste in the sea were made and removed as follows :

On the Bahr Mahalla: made 1st January, removed 3rd September
» » Tira » 15th February, » 31st August
» » Shibin » 15th January, » 31st »
» » Nashart » 25th March, » 18th »

The late date of the removals of these "Sadds" was due to the deficient Nile flood.

26. — The summer was a hot dry one, and it was only by constant personal exertion and exposure that Mr. Willcocks managed to keep the great cotton crop alive. On the 15th May he commenced the rotation of irrigation by closing the canals for seven days out of twenty one. From the 20th June he could only

keep them running seven days out of fourteen. From the 5th July to the 11th August the canals were closed for fourteen days out of twenty one. This was fatal to the rice crops, the interest of which it was necessary to sacrifice in order to keep the cotton crop alive.

27. — *Beherah and Giseh.* — The most important thing to be done for the irrigation of Behera is the restoration of the Rayah Behera, or canal taken from above the Barrage, to enable it to carry water sufficient for the irrigation of the Province, and to render it independent of the costly pumping at Afteh and Khatatbeh. There is no other canal in Egypt so unsatisfactory and so discouraging. Large sums have been spent on it year by year and yet it is until now practically valueless. It would have probably been easier and cheaper to have made an entirely new canal than to have gone on as we have done trying to restore to usefulness a very bad canal.

In 1885 and 1886 the unfortunate experiment was made of running this canal during Nile flood, in the hope that a scour would be produced and the bed deepened. Exactly the contrary effect took place. The sandy banks fell in, and the bed widened and was choked by a deposit of sand. Some of this was cleared away early in 1887, but the great flood of that year burst through its banks and again a great sand deposit was formed. All the dredging done since then has failed to bring the canal to a proper level. and the irrigation of Behera is really effected by the pumping stations.

But in spite of all discouragement the Rayah Behera is being put into order. I am hopeful that after 1st May 1890 we shall be able to dispense with the Khatatbeh pumps, and in 1891 that Behera will derive its irrigation from this canal, and no further pumping will be required.

28. — As already stated in para: 11 the quantity dredged from the Rayah Behera and Khatatbeh canals during 1888 was 563,745

cubic metres at a cost of L.E. 23,448, besides which L.E. 4,039 were spent on work which had been done during 1887. The cost of dredging the canal altogether since 1885 has been L.E. 60,531.

The process of narrowing the too wide channels by brick groynes or spurs was carried on throughout the low Nile, and L.E. 6,012 was spent on this head. Mr. Foster reports that from kilo. 12 to kilo. 30 both banks are now well protected with spurs, 200 metres apart on straight reaches, and as near as 60 metres to each other on curves. The spurs are now all composed of burnt bricks, the cheaper materials used experimentally in former years having proved a failure. They have cost altogether as follows :

1886	L. E.	6,205
1887	»	8,033
1888	»	6,012

The sum of L.E. 585 was further expended on screens along the west bank to arrest the sand drift. Since 1886 we have tried to carry the muddy flood water into the desert plain west of the Rayah Behera with a view of encouraging cultivation and checking sand drift, but the results are not yet of much value.

29. — The pumps worked as follows throughout the year 1888.

	Commenced pumping	Finished pumping	Days working	Mean daily discharge — cubic metres
Atfeh...........	25th Nover 1887..	25th August 88..	276	1,775,362
Khatatbeh......	8th February 88.	12th » »	185	2,371,190
Total discharge per diem........				4,146,552

The amount paid (see appendix A, VII) to the Behera Irrigation Society for this water was L.E. 61,255. It would have been well to have begun the Khatatbeh pumps at an earlier date. As it was during the cotton crop and until the Nile rose the pumps were daily supplying 5.25 millions of cubic metres, a larger volume than was ever furnished before.

30. — The dredging ceased and the Rayah Behera was opened on 1st June, but it only added 500,000 cubic metres to the daily discharge. The system of giving irrigation by rotation on different canals was practised again this year in Behera, and met with the same unreasoning opposition. I trust now however the agricultural classes have learned that this system is not one of choice, but of absolute necessity if the present area of irrigation is to be maintained in summer.

31. — In para: 44 of the Report for 1887 it was explained how during the rise of the Nile flood Behera suffers in comparison with the other Provinces from the tardiness with which the increased volume can be delivered on to its lands, and it was stated that a solution was being sought for this in opening a new flood channel to supply the Khatatbeh canal north of the railway crossing at Kafr Zayat. The project for this new feeder canal was approved by the Government on the 9th April 1888, and work was begun at once. The new Kafr-el-Ess canal is only 1000 metres long from the river to the Khatatbeh canal. Its bed width is 20 metres, and in an ordinary year it should be flowing two metres deep about the middle of August. Just to the south of where the new feeder joins the Khatabeh is a regulating bridge for controlling the water in that canal. The intention is then to force all the water that enters the Rayah Behera and the canal at Khatatbeh into the branch canals south of this regulator, and to irrigate the north eastern portion of the Province from the new canal. At the beginning of September when the water coming down the Khatatbeh does not usually exceed 8 $\frac{1}{2}$ millions of cubic metres per diem, the new feeder should be carrying 5 $\frac{1}{2}$ millions of cubic metres, a gain to the Province of nearly 65 °/₀ of volume of water at a most important period. Most unfortunately an error of 70 centimetres was made in the levels

APPENDIX D.

Note on the desirability of head regulators to basin feeders by Captain R. H. Brown R. E., Inspector of Irrigation, 4th Circle.

In considering the question of the desirability, or otherwise of providing a Nili canal with a masonry regulator at its head, the following must be borne in mind.

The uses that a head regulator would serve are :

(*a*) To keep out the early Nile water, until the *Sefi Durra* is harvested, that is, until the 10th to 15th August.

(*b*) To shut off the supply at the time of discharging the basins, so that the emptying of them may not be delayed by water continuing to flow into them.

(*c*) To prevent over flooding of the basins by keeping the inflow under control.

(*d*) To prevent the water of the upper basins flowing back into the Nile, in case of the Nile fall commencing too early with reference to the date for discharging the basins.

(*e*) To enable the supply to be shut off in case of accident, such as a breach along the chain of basins, so as to allow of the supply being temporarily checked, while the breach was repaired.

(*f*) To economise the amount of waterway required in the bridges between the basins and in the escape at the tail of the chain.

2. — (*a*) An escape of whatever size at the tail of the section could not keep out the Nile water till the required date, and in the absence of regulators at the heads of canals, it is under present circumstances found necessary to make an earth bank across the canal mouth which is cut on the said date but, cannot be removed entirely, so that it results that, in Low Niles, when it is important to get the full discharge of the canal, the flow is checked at the intake.

(*b*) If the head is not closed at the time of discharge, it would be necessary to enable the basins to be emptied as soon as they would be, were the mouth of the canal closed, to provide extra water way at each cross embankment and also in the escape at the end to correspond with the discharge still flowing in, and to provide a continuous channel from mouth of canal to escape. (This latter would probably exist, or have to be made in any case).

G. — Level and survey chart of the Province.

The following is the progress made under these 7 subheads :

A. — *Dam at kilo. 12-14. — Transfer of canal heads.*

We have come to the conclusion that Lahun is not dangerous if pitching is maintained, and that the old or downstream Bridge whose downstream face fell in before the arrival of the English, can be maintained secure by pitching.

A pitched slope is added to yearly and spurs are added to throw the whirlpool off the wing walls downstream.

The canals on the left have been found by levelling to be far below present surface level of Sefi, and the Sela at kilo. 10 Bahr Yusuf, the great canal to the right, has been given a secure supply by a loose stone weir at kilometre 12 Bahr Yusuf.

I have, after much study, came to the conclusion that owing to Ravines which must be crossed, the country to the right between kilometre 12 and 17 cannot be safely nor permanently irrigated by a parallel high level canal on the right, and that it is necessary and more safe and economical to syphon under the Bahr Yusif at 15 $^1/_4$ kilo. and take the high level water at present from above the stone weir at kilometre 12 and eventually from above Lahun.

After Lahun has been set in order to maintain the high winter and flood level for the Bahr Wardân, the left parallel canal will then readily be taken along the desert and crossing under the Bahr Yusif by the syphon at 15 $^1/_4$ irrigate all the country to the right by free flow, and thus avoid the great Banks over the Ravines.

B. — *Establishment of great drainage channels. — Bats et Tamiyah.*

This great Ravine is supplied by a sluice in the Bahr Yusuf near kilometre 18, and the supply turns numerous wheels which lift the water out of the Ravine. The water after passing down the Ravine feeds the Sarb and Radah canals which irrigate the lower levels of the Bahr Wardan system. The numerous canals on its left bank from the Bahr Yusuf escape their excess water into this Ravine and thus there is a large supply passing down in flood time which falls over Tamîyah wall and then into the Birket-el-Qârûn.

The idea of reserving this ravine exclusively for drainage has been abandoned, partly owing to the great difficulty of maintaining its existing wheel lift irrigation, and partly owing to the fact that the water passing down the Ravine even in summer is not deteriously salt. The absorption in the Ravine is nil owing to the bed being rocky in most places.

Until the Bahr Wardân on the right of the Ravine delivers summer supply (Sefi) throughout the season and the broken ground to the right of the Bahr Yusuf between 12 and 17 kilometres is irrigated easily by the syphon proposed escapes could pass off. Should they dicharge an excessive amount in exceptional years, and the escape, owing to the want of difference of level between the tail basins and the river not be able to pass it back into the river, they, being of small section, could be closed by stones, as this condition would not occur often.

4. — It is possible in a very High Nile, that the main feeder, without a head regulator, would pour such a volume into the terminal basins of the chain, and the Nile opposite this basin be at such a high level that the tail escape would not discharge sufficient until the level of water in the basin has risen to a dangerous height. Such a state of things, the head regulator would prevent.

I append to this Note a sketch of an ideal chain of basins such as I have had in my mind and while writing this. The group of basins represented are similar to the group to the south of Sohag from Salibah Samhûd to Sohag, but the main feeder has been simplified by assuming one instead of three, and omitting all complication due to subdivision of basins along and adjacent to the Sahel.

(Signed): R. H. Brown, *Captain R. E.*

E. — *Reclamation of various desert tracts.*

There are all round the Fayum signs of a more extensive cultivation which, it is believed, existed between 1,300 and 1,500 *A. D.* The retrogression of levels of the Bahr Yusuf, and the formation of ravines by disastrous breaches, and the non-maintenance of the great Miniya wall aqueduct caused the abandonment of this irrigation, and there are now about 60,000 feddans of black soil deposit varying from 2 metres to 20 centimetres deep lying waste and the villages in them marked by mounds. They have nearly all been given out under the decree of 1884. They are 3 in number :

(1) The north edge of the Fayum containing 45,000 feddans. This will be irrigated by the Bahr Wardân at an estimated cost of L. E. 35,000. The survey has been pushed up to Kom Wasîm and reconnaissance has shown that the deposit reaches to the further edge of the Birket-el-Qârûn. The old canal still exists and has its head marked by enormous mounds of silt at kilometre 10 Bahr Yusuf which has here sunk at least 2 metres in surface level.

(2) The Hasan Pasha Fadil concession.

This strip containing 3,000 feddans lies between the Bilâmah and the Bats-el-Tamiyah two ravines worn by the water from Bahr Yusuf breaches. A canal exists in the strip and two corresponding canals exist on the other side of the dividing ravine taking from the Bahr Yusuf. If the ravines were non existent, the Bahr Yusuf would irrigate this easily.

The owner of the concession, Hassan Pasha Fâdil, has tried to dig a canal and has failed, and still has either to bank across the ravines or make a syphon under the Bahr Yusuf to bring high level left water from the stone dam at 12 kilometre.

(3) The Abu Nur and Lower Nezlah tract.

This tract was irrigated by a canal which was the prolongation of the Bahr Arûs. It crossed the Minya Ravine by a masonry aqueduct of great length, and the traces of the canal exist at the Shekh Abunnur at the southern extremity of the wall. The canal is visible in the desert all down the southern edge of the Fayum and has given a deposit of black soil at *Batn Harit* and *Qasr-el-Binât* at a level from 2 to 4 metres higher than present levels. The ruins of aqueducts near the great wall of Minya are very striking. This wall was latterly used as the dam for the basin recently abolished. Various concessionnaires have by private efforts and subscriptions irrigated about 2,000 feddans out of the total of 12,000. Much of the soil has been unfortunately removed by wind leaving only from 30 to 50 centimetres on the rock.

A study has been commenced of this tract, and in 1888 a definite project will be submitted.

Mr Bouteron, of the Domains, is however averse to any great extension of cultivation, as he fears that the sparse population of the Fayum will be unsettled by so much reclamation and will forsake the older cultivation and thus cause rents to fall. The further side of the lake and the slopes of the right and left present a large area of old black soil. This was not been surveyed. It is proposed to survey this in 1889.

The million being exhausted, it is proposed to form companies of the concessionnaires, and thus dig the canals necessary to reclaim these tracts. The Sefi supply cannot however be guaranteed until the formation of the Wadi Rayyan reservoir.

F. — *Gradual conversion of the Ravine canals into drains.*

The canals which flow into the lake have owing to the excessive fall, become Ravines. Masonry overfalls are built at intervals along them to maintain the water at a sufficient height to flow on to the fields. It was proposed to enlarge a few of these canals and abandon the greater part of the ravines. As the water is all consumed in irrigating the lower levels, these projects have been abandoned.

G. — *Level and Servey Charts of the Province.*

A survey establishment has been maintained on the million by which an extensive series of levels have been made of about $^2/_3$ of the Province. There now remains a strip about 12 miles broad between Abuksah and Tamîyah to survey and level. It is hoped that the summer of 1889 will see the levelling finished.

The remaining survey will be paid for from the Ordinary Budget.

Altogether about L. E. 7,000 exclusive of establishment has been spent in the Fayum and has done an immense amount of good. About L. E. 2,000 a year spent in improvement during the next 5 years will put the Province in good order.

The increase of irrigation has been most striking owing to the confidence felt in the certain summer supply.

(Signed) : J.C. Ross, *Major R. E.*

Existing bridges to be made use of to the fullest extent possible and no more cuts than absolutely necessary made.

To Chief Engineer, Assyût.

Bridge Gabel Assyût in the cross embankment of Hod Zenar to be closed on the 5th October. The centre arch of bridge Magdub, (having again burst open as in 1886) can be left open, on account of the difficulty of closing it.

The bridge of the basins from Assyût to Dalgawi basin will be opened fully, commencing from the North, on the 5th October (unless in any case regulation is required to complete the inundation of any basin). No cuts, unless absolutely necessary, are to be made. The discharge is not to be hurried, but may be prolonged to the end of October.

Hod Tanûf and Ashmûnin require no further cuts: They will empty themselves as the level of the Yusufi falls.

The Yusufi head atDerût will be closed to the extent possible, commencing from the 5th October.

Minyâ.

As soon as the Yusufi is low enough, but not before the 7th October, after the completion of the inundation of each basin, the existing bridges in the basins to be opened, (if not already open), and the discharge by successive basins be gradually made into the Yusufi.

The discharge is to be gradual and may extend to the end of October. The Salibet Kom-el-Saâydeh is not to be cut except at the request of the Chief Engineer Beni Sûef.

Beni Sûef.

As soon as the basins are completely inundated, but not before the 10th October, the general discharge may begin, all basin feeders being previously closed. No more cuts than may be absolutely necessary should be made. The bridges should be utilized to the fullest extent possible.

To avoid having to make a cut from Nina basin, its bridges should be opened 4 or 5 days before the date for commencing the general discharge. The discharge should be gradual and may extend to the end of October, or to a date a week or so later than in 1886.

Towards the end of October, should the present opening in Abu Khadigah stand so long, it may be necessary to make another cut in the Koshesha bank, and if so, this will be made to the south of Nasri bridge. As soon as the Inspector of Irrigation, 3rd Circle, permits the opening of Komi bridge, it should be fully opened, and Bridge Sabah also opened as far as the level of Riqqa basin will allow. Riqqa basin will discharge itself as the river falls, through Komi and Attwab bridges.

3. — The above instructions were generally carried out, but were modified during the progress of the discharge to some extent, and disobeyed, I believe, in only 2 instances, viz: in the making of two quite unnecessary cuts, one in

of road by levelling embankments and filling in cuts. He reports that the left bank of the Ibrahimieh canal for 30 kilometres north of Minieh is now a good road. The Western *Muhit* (or longitudinal embankment separating the basins on the west from the Ibrahimieh canal cultivation) is now a good unbroken road from Ashmun to Beni-Souef 138 kilometres. The central *Muhit*, an embankment running north and south through the middle of the *Sefi* irrigation is now a good road for 54 miles from Matai to the canal Sultani, north of Feshn.

Private individuals have built good wooden bridges across the Ibrahimieh canal at Mellawi, Magussa, and Samalout. The difficulty is to induce the natives to respect the roads and bridges made entirely for their own benefit. Across the former they think nothing of cutting deep ditches if it is the least help to their irrigation. The latter they destroy for the sake of the timber which they steal. Major Brown built four wooden bridges across drainage channels last year. In less than a year three of them had disappeared altogether, and part of the timbers of the fourth had been stolen.

47. *Keneh and Esneh.* — The new works done this year are N^{os} 32 to 35 of Table II, Appendix A. The regulating bridge in the Escape from the Gebelan Basin, Shansurieh series was begun last year and now is finished. The Rinan syphon which gave so much trouble as regards foundations in 1887 was also finished in 1888, although a charge of about L. E. 430 for pumping the foundations dry was not paid before the end of the year. Table IV gives the details of outlay on maintenance. Repairs were done to 19 indifferent masonry works.

48. — In previous reports I have noticed how slow the Corvée was to diminish in the Southern Provinces. I am glad to say 1888 shews an improvement here. There were 13,740 men employed for 100 days (see Table at para: 9). In 1886 there were 20,436

It will be remarked that the old system of handing over the water from Province to Province in succession has been abandoned in my Circle. This time-honoured ceremony, however, took place between me and Abu Saûd Bey on the 2nd October, and the usual documents considered necessary on the occasion were sealed.

I have the honour to be,
Sir,
Your most obedient servant,

(Signed) R. H. Brown, *Captain R. E.*
Inspector of Irrigation, 4th Circle.

APPENDIX F.

Memorandum on the Kom Ombo deposit, by Major J. C. Ross C. M. G. Inspector General of Irrigation.

I took the opportunity afforded by the steamer stopping for an evening at Kom Ombo to walk into the ancient Basin.

I walked 3 ½ kilos from the temple and about 2 ¾ from the edge of the cultivated land. The cultivated land ends abruptly in a clay and sand cliff which shows Nile mud in its section most distinctly. It is about 7 metres above Highest Nile of 1887 which breached into the cultivation. At the foot of the cliff, the people dig wells through about 2 metres of light loan, and then in 3 metres of hard mud deepening them, as the Nile falls, and they irrigate the wheat and durra of the desert edge which is generally sown on sand.

A curious thing is seen in the talus of the cliff which is nearly all sand, the mud having been weathered out and blown away. The whole talus is covered with small quartz stones and up above none are found. From what I have seen in cranes' stomachs, I consider these stones have been voided by birds of the water tribes.

Once on the flat, one readily sees the amphitheatre of hills surrounding the old Lake. The surface of the ground is thinly strewn with black stones of a granitic or Basaltic type and with large quartzite pebbles (rare) and varieties of jasper and indurated clay. I picked up in the short walk a number of flint chips, arrow, and lance heads of the stone age.

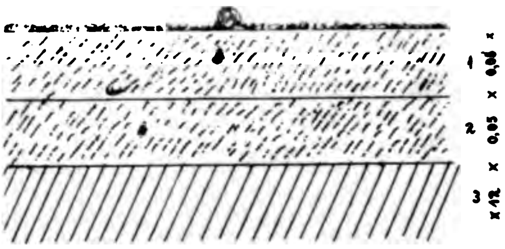
The people remove the desert subsoil for Sabâkh and have got out to about 2 kilos from the edge. The soil of the desert is soft and powdering to the foot, and strewn with light gray lumps and a brown yellow sand of extreme fineness.

The section in the first 2 ½ kilos into the desert is very constant and is as follows:

Yellow brown sand and clayand gray concretions.

Pulverized brown clay with gray concretions.

Dark clay with gray concretions.



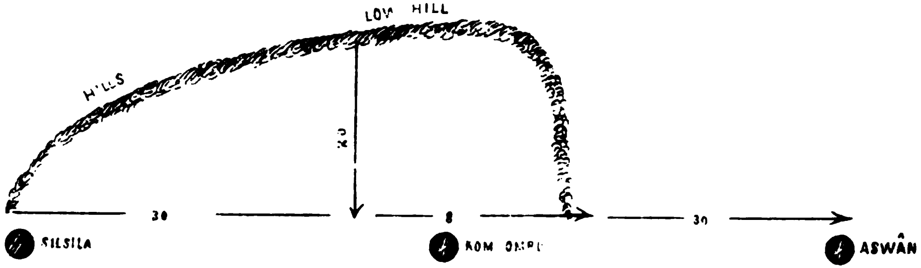
On the extreme top, the sand is almost yellow and looks sandy to the eye, but the moment the foot kicks up the dust the brown is easily seen. The gray concretions are very numerous. The above is clearly a clay deposit of remarkable homogeneity, but judging from the nonchange of bricks of great antiquity in other places and the non existence of gray concretions in old Nile deposits, I think that this deposit must be much older than man even.

The plain is remarkably free from drift sand ridges or hummocks.

From what appeared to the eye in the evening Gebel Silsila was by far the most distant point. It was due West of Kom-Ombo, and the Lake seemed to be shut in by hills on the south very closely. On the map, I find them to be not more than 8 kilos off. Aswan lies at the end of the valley 38 kilos from Kom-Ombo on the straight.

Gebel Siesila is 30 kilos off, and making every allowance for the setting sun's light bringing the opposite hill nearer, I do not think the eastern boundary is more than 20 kilos off.

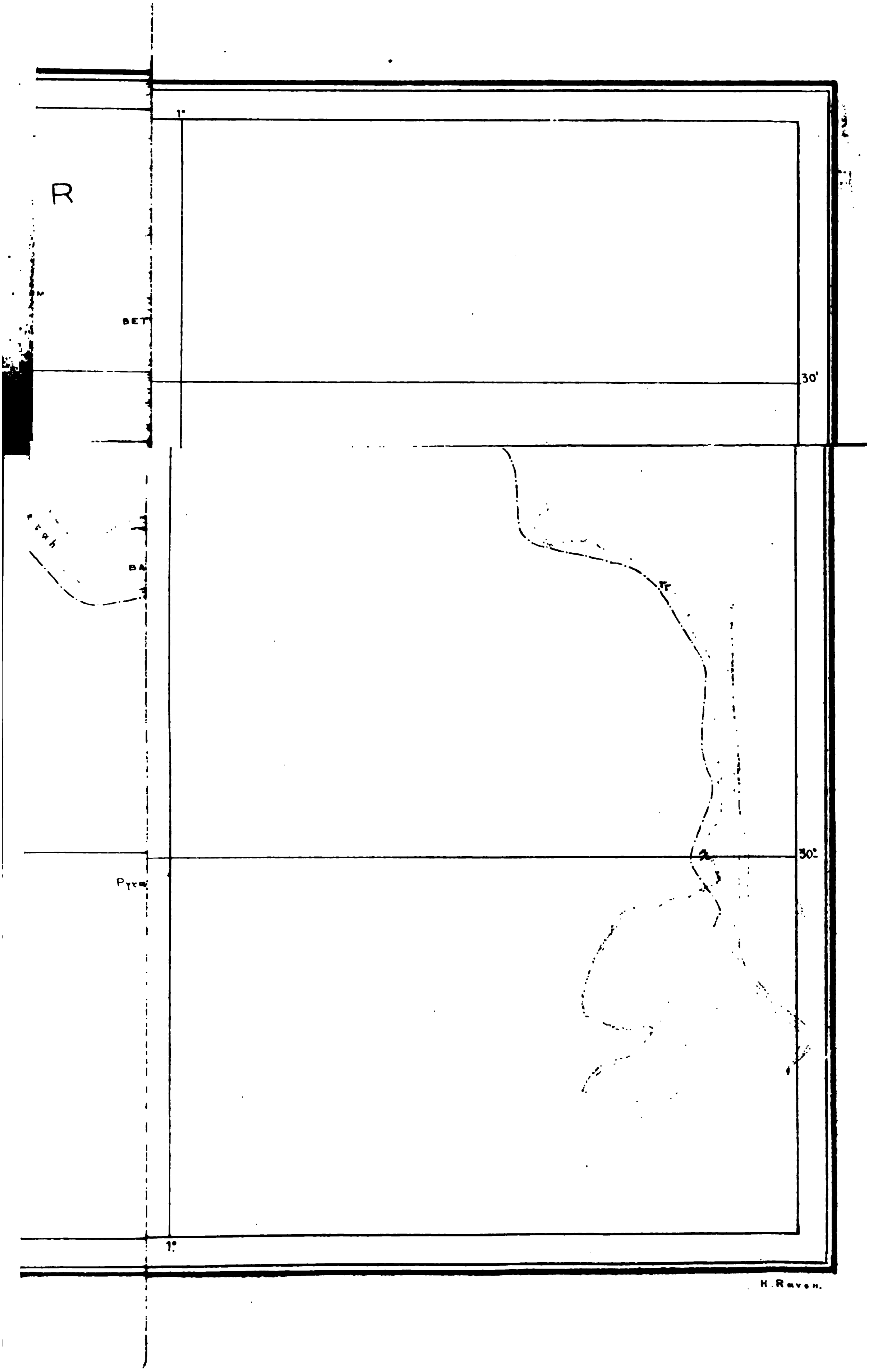
There is a decided dip in the hills in the south-east corner of the basin.



This gives the eastern plain about 760 square kilometres or about 180,000 feddans.

As the soil is level and thoroughly good, we could readily spend L.E. 2 a feddan on it or L.E. 360,000. This probably would cover the cost of the somewhat difficult canal from Aswân.

(Signed) : J. C. Ross, *Major R. E.*



H. Raven.

APPENDIX A.

PUBLIC WORKS MINISTRY

IRRIGATION BRANCH — EXPENDITURE FOR 1888.

N°	NAME OF WORK	OUTLAY IN 1888	OUTLAY previous to 1st Jan. 1888	TOTAL OUTLAY	REMARKS
		L. E.	L. E.	L. E.	
	I. — The Million Fund.				
1	Barrage, Rosetta Branch	31,607	96,400	128.007	
2	» Damietta Branch	109,038	...	109.038	
3	Rayahs Tewfiki-Earthwork	80,654	127,750	208,405	
4	» Price of land	1,382	21,095	22,477	
5	» Head Regulator & Lock.	20,445	7,521	27,966	
6	» Two syphons	5,287	2,852	8.139	
7	» Two small Regulators	989	2,477	3,466	Finished
8	» Two Rail. swing Bridges	9,824	3,249	13,073	
9	» Bahr Moes Reg. and Lock	10,553	4,975	15,528	
10	» Gangara do. do.	8,076	...	8,076	
11	» Minor Works	406	1,967	2,373	
12	Mitghamr Regulator and Lock	8,633	18,755	27,388	
13	Railway Bridge-Mansurieh canal	446	1,491	1.937	do.
14	Mansurah Lock	3,763	22,565	26,328	do.
15	Kalangil Lock and Regulator	10,292	7.188	17.480	do.
16	Ananieh Creek syphon	..	1,225	1,225	do.
17	Damietta Reservoir	430	11,163	11,593	do.
18	Head Lock, Rayah Menoufieh	3,890	11,332	15.222	do.
19	Lock at Head of Bagurieh canal	5,521	7,442	12,963	do.
20	» Shubrabas on Bagurieh canal	7,343	4,667	12,010	
21	Railway swing-Bridge, Dalgamun	1,800	1,100	2,900	
22	Kodaba Lock	1,801	6,339	8,140	
23	Santa Lock and Railway swing Bridge.	4,260	5,011	9,271	Bridge finished
24	Works on Bahr Saidi-Gharbieh	...	14,682	14,682	
25	Kafr Dawar Lock and regulator	9,730	2,684	12,414	
26	Syphon under Mahmudieh canal	3,654	...	3.654	Finished
27	Rosetta canal	...	24,876	24.876	do.
28	Feshn syphon-Ibrahimieh canal	4,519	13.386	17.905	do.
29	Works in Tyur Basin-Fayum	...	4,504	4.504	do.
30	Wadi Rayan survey	368	497	865	do.
31	Minor Works Fayum	1,248	. .	1.248	do.
32	Mitrodeny syphon-Wadi canal	..	1.000	1.000	do.
33	Sundry Minor Works	946	711	1,660	do.
	Establishment, travelling allowances, etc.	16.155	33,367	49.522	
	Tools and Plant	5,990	15,389	21.379	
	TOTAL	369,053	477,562	846,615	

PUBLIC WORKS MINISTRY

IRRIGATION REPORT

FOR

THE YEAR 1888

BY

COLONEL SIR COLIN C. SCOTT MONCRIEFF, K. C. M. G., C. S. I.

CAIRO
NATIONAL PRINTING OFFICE
1889.

REPORT

of the Administration of the Department of Irrigation for the year 1888.

1. — The following table gives the total expenditure of the year compared with that of 1887. The details will be found in appendix A.

	SPENT 1888	SPENT 1887
	L.E.	L.E.
NEW WORKS: Ordinary Budget	25,156	29,798
» Million Grant	346,908	342,479
» Special (Nubarieh Canal)	45,965	23,453
REPAIRS AND MAINTENANCE: Ordinary Budget	117,918	105,804
» » » Corvée Relief	249,846	233,561
» » » Corvée Ransom Fund	74.050	4,046
Payment for water pumped by Behera Irrigation Society	61,255	53,851
TOOLS AND PLANT: Ordinary	662	820
» » Million Grant	5,990	6,544
TOTAL..... L. E.	927,749	800,356
ESTABLISHMENT: Ordinary Budget	48,525	44,054
» Million Grant	16,155	16,758
Add 75 0/0 of Central Administration	31,156	25,590
Total Establishment.... L.E.	95,836	86,402

The Establishment charges are therefore 10.3 per cent of the money expended on works. In 1887, the percentage was 10.8.

The excess this year in the cost of maintenance both on the ordinary Budget and the Fund for Corvée Relief is chiefly on account of the mischief done in 1887 by the very high Nile floods. The large sum received as Corvée ransom is balanced by the smaller number of men called out to forced labour, but the number of the latter is still too great.

know that this area would have been much greater, but for the measures carried out under the direction of Lieut. Col. Ross during the last three years, and the vigorous action of Mr. Willcocks who accompanied the Minister of Public Works in a tour to Upper Egypt in September, and took such active steps as to save a large area in Girgeh from barrenness. Mr. Willcocks' report on the subject will be found in the appendix C.

4. — Throughout this year it was on the Barrage at the head of the Damietta Branch that work was carried on. Consequently a less supply was sentdown it and the Eastern Provinces on its rights bank had less water than usual. By enforcing a system of rotation however Mr. Garstin secured the cotton crop from any actual loss.

5. — The usual temporary dams on the Damietta Branch below the heads of the Sahel canal and Bahr Moes, below that of the Mansurieh canal and North of the town of Damietta were made and removed. The first of these has been made yearly since 1885, the others since 1886. I hope that this year (1889) will be the last in which they will be required, and I shall be glad of it: for not only are they expensive, but their effect on the river bed year after year is not good.

The net cost of the dam North of Benha was L. E. 1,602, of that North of Mïtghamr L. E. 4 030. North of Damietta only L. E. 136 was spent in repairing the earthen dam of 1887. This was remarkable considering the force of the flood of 1887. It was not intended to close the river, but merely to narrow its mouth and so produce an outward current. But Mr. Garstin reports that so little water was sent down that it only succeeded very partially and the salt water penetrated as for as the village of Zarka, 30 kilometres above Damietta. As regards this Mr. Garstin states that.

> The engines on the Nile bank had to pump brackish water for a time. Wherever this was done, although the rice was killed, the cotton as regards both the quality and out-turn was better than it was anywhere else.

Col. Ross suggests that possibly the brackish water killed the cotton worms.

6. — On the Rosetta Barrage the usual dams were erected at Khataтbeh to hold up the water to enable the pumps to work, and at Mehallet el Amir to keep the salt water from coming up to Atfeh. The former cost L.E. 819 only, instead of L.E. 2,329 in 1887, and L. E. 2,609 in 1886. The great Mehallet el Amir dam has cost as follows:

In 1886	L. E.	11,384
In 1887	»	10,649
In 1888	»	10,370

It is much to be desired that we should be able to dispense with these yearly dams, but owing to the inefficient condition of the Rayah Beherah I fear the necessity for them will continue some years after they have ceased on the Damietta Branch.

7. — The cotton crop of the last five years is given by the Finance office as follows:

	Kantars	Tons
1884	3,591,486	156,151
1885	2,904,842	126,298
1886	3,025,965	131,563
1887	3,046,485	132,456
1888	2,699,103	117,352

A better crop than this was expected and various reasons are assigned for its failure, none in any way affecting the irrigation.

weepholes. Some of them were silted up so as to be quite water tight, whilst others threw a full bore of mud and water to a height of nearly two feet. Under arch N° 71 and in the floor downstream of it there were 37 of these holes and between three and four hundred in the 41 arches dealt with. They were each closed by driving in a wad of tow with a tapered wooden plug. When home the plug was sawn off level with the floor and covered with rubble masonry laid in cement.

Arches N^{os} 37 and 38 were found to have no floor. The concrete of the foundation appeared to have been skipped in and left at a level of about .5 metre below floor. The top of this concrete was rough and of very bad quality, the mortar and the metal having separated and formed into strata and pockets like a much disturbed geological formation.

It was leveled down and all very bad portions were removed to as great a depth as was possible with safety. New work was then built to a thickness of 2.25 ms.

The *sadds* as originally constructed enclosed 34 arches only. As work progressed new dams were thrown out so as to enable the repairs to be carried past the centre arches leaving so little work undone as to make the completion of the bridge as far as possible a certainty in one more working season. These extensions as before stated enabled the eastern 41 arches together with the end lock to be put in order.

The work done was as follows:

The whole of the existing floor of the Barrage both upstream and downstream as well as under the arches was raised from R. L. 8.25 to R. L. 9.5 with the exception of arches 70 and 71 which, owing to the badness of their floors, were raised to R. L. 10. This was done as on the Rosetta Barrage with concrete in cement faced for a length of 7 ms. under the gates with Trieste stone ashlar and elsewhere with ashlar of old Cairo stone. This new floor was carried upstream and downstream beyond the arches to the limits of the original floor. An upstream apron of rubble masonry 25 ms. wide and 1 m. thick was added, a row of piles being driven at 5 ms. within its upstream edge to a depth of 5 ms. below its underside. On the downstream side an apron was also built. Its thickness was 1.5 ms. and its width 10 ms. from arches 42 to 71 inclusive whilst from 31 to 42 the width was increased to 15 ms. and the thickness to 2 ms. on account of the badness of the soil.

The lockwalls both upstream and downstream were protected with an apron 12 ms. wide sloping from R. L. 12.0 at the wall to R. L. 9.5. Along the whole of the downstream edge of the floor, and at a distance from it of 5 ms., a row of rubble masonry blocks was built, each block being 5 ms. by 3 ms. by 1.5 ms., the space between this row of blocks and the edge of the floor being filled in with dry stone pitching covered with a layer of rubble blocks 2.5 ms. square and .75 m. thick. Beyond the outer line of blocks pitching was put in wherever there was place for it up to the level of the floor.

MUDIRIEHS	N° of Corvée for 100 days	N° who ransomed themselves	N° of Corvée employed in 1883 100 days	WORK done by Corvée	WORK done by contract Corvée Relief Fund	WORK done contract by Corvée Rans. Fund	TOTAL WORK done by contract	TOTAL WORK done Corvée & contract	Sum spent of Corvée Relief	Sum of Corvée Ransom	TOTAL SPENT
	Number	Number	Number	Cubic Metres	Cubic Metres	Cubic Metres	Cubic Metres	Cubic Metres	L. E.	L. E.	L. E.
Kaliubieh....	1,538	...	7,621	204,919	445,764	...	445,764	650,683	15,070	75	15,145
Sharkieh-....	...	29,986	18,238	...	643,502	579,598	1,223,100	1,223,100	22,000	11,964	33,964
Dakahlieh....	6,633	28,950	20,605	968,733	941,804	339,592	1,281.396	2,250,129	23,133	9,234	32,367
Menoufieh....	...	51,337	26,887	...	447,192	875,987	1,323,179	1.323,179	18,111	12,493	30,604
Gharbieh. ...	2,804	19,328	25,093	270,537	1,638,671	810,525	2,449,186	2,719,723	26,136	14,942	41,078
Behera.......	3,508	192	8,172	354,072	664,036	1,500	665,586	1,019,658	20,826	248	21,074
Giseh........	1,538	21,667	5,929	290,546	690,715	478,579	1,169,294	1,459,840	37,464	6,484	43.948
Fayoum	1,807	...	6,255	226,643	462,293	...	462,293	688,936	7,244	58	7,302
Beni-Souef....	3,397	...	8,217	640,256	520,390	...	520,390	1,169,646	8,000	...	8,000
Minieh.......	5,567	3,766	11,838	1,163,160	806,618	115,814	922,432	2,085,592	10,000	1,129	11,129
Assiout......	4,636	59,038	25,068	1,119,617	1,015,571	1,190,324	2,205,895	3,325,512	16,326	17,423	33,749
Girgeh.......	13,620	...	15,366	1,973,555	1,103,447	...	1,103,447	3,077,002	16,000	...	16,000
Keneh, Esneh.	13,740	...	22,601	1,672,262	2,073,561	...	2,073,561	3,745,823	27,461	...	27,461
Barrage......	...	...	...	...	...	...	...	...	2,075	...	2,075
TOTAL...	58.788	214,264	202,650	8,893,300	11,453,594	4.391,929	15,845,523	24,738.823	249,845	74,050	323.595

on strengthening embankments that the clearance of canals was neglected, from which serious results occurred when the Nile flood failed.

10. — Among the peasant proprietors of Lower Egypt the Corvée Redemption has been very popular, and large numbers have readily paid. It is not so among the large proprietors and owners of *Esbehs*. Many of these are Europeans, and they look on themselves generally as a privileged class who are entitled to all the State can give them without rendering the slightest service in return. Mr. Willcocks calculates that while the numbers who paid ransom money per 100 feddans were among the *fellahin* of Menoufieh at the rate of seventeen men and in Gharbieh of seven men, the holders of *Esbehs* paid in Menoufieh only for two men per 100 feddans and in Gharbieh for two men for 500 feddans. This glaring evil we must hope will be rectified ere very long.

11. — The dredging done by Messrs. Fox and Anderson in the three Eastern Provinces was on the whole satisfactory. It amounted to 637,599 cubic metres against 802,795 done in 1887, but as 206,812 cubic metres dredged in 1887 were not paid for until 1888, they appear in financial accounts as belonging to the latter year. Of course it would be more satisfactory if such a large quantity were not required, but clearance done by dredging instead of hand labour is generally a gain.

In Beherah, Mr. Foster reports that for the first time the dredging was done in a satisfactory manner by the Beherah Irrigation Society. The volume dredged in the Rayah Beherah and Khatatbeh canals was 563,745 cubic metres, against 522,111 in 1887. On the smaller canals of Beherah, 41,978 cubic metres were dredged. This was the first year dredgers were ever at work on these last.

12. — *Extraordinary Grant of one million.* — The expenditure on this grant has been as follows :

In 1885 (establishment only)....	L. E.	8,187.484
In 1886	»	106,308.538
In 1887	»	365,782.409
in 1888.......	»	366,335.593
Balance unspent 1st January 1889..	»	153,385.984
Total.....	L. E.	1,000,000

The works were in full progress throughout the year, and were successful except that as not unfrequently happens the engineers' estimates were generally exceeded. I noticed in paragraph 21 of last year's report the trouble we had in finding in Egypt any contractors really capable of undertaking difficult hydraulic works. This trouble is by no means lessened, on the contrary it is rather increased owing to the pressure that has been sometimes put on this Ministry to accept the lowest tender for the execution of works. With the experience of the last three years I can say without hesitation it would have been better economy in the long run had we always accepted the highest bid, rather than always the lowest, but it is difficult to make people understand this.

13. — Appendix B contains Mr. Reid's report of the work done at the Barrage. He remarks :

> The difficulties met were not so great as during the previous year, as there was no actual failure of the floor to deal with, but they were sufficient to prove the necessity of the work undertaken.
>
> The experience gained during 1887 was of great value, and the training received by both the establishment and the contractors contributed largely to the facility with which the work was done. Accident and illness amongst the former gave however great trouble, as there exist in Egypt no reserves of trained men to fall back upon.

14. — The earthwork of the Rayah Tewfiki or great Eastern Trunk canal was completed by the 1st August with the exception of the few banks left across it for purposes of convenience. This will be removed after all the masonry works have been finished.

The foundations of the masonry works on this canal have given great trouble. I noticed last year that it had been necessary to change the design of the Head lock and regulators owing to the nature of the mud and slush encountered. The work was finally built on the common Indian system on 134 brick cylinders or four sided blocks under all the walls, and surrounding the flooring up and downstream like a coffer dam. The cylinders or wells varied from 2.50 to 4.50 metres in external diameter. The blocks were generally 3.50 × 2.50. All were hollow inside and were sunk by dredging to a depth of 5.50 metres below the bed of the canal. These blocks and wells were filled with concrete. The joints between them were closed with piles. Their upper surfaces were from 1 to 2.50 metres below canal bed, and over this was laid a bed of concrete and masonry. The concrete of the flooring and the rubble masonry aprons up and downstream were finished and the water allowed to rise on the 13th August. Up to that time the whole work was done under heavy pumping.

15. — The irrigation syphon under the Tewfiki canal at 900 metres from the head also gave great trouble with the foundations. It is now finished. The masonry of the two railway bridges near Benha was practically finished. These works have been carried on very slowly under the Railway Administration.

The lock and regulating bridge for the head of the Bahar Moes had been just begun in 1887. Here too the foundations caused much trouble, and we had to build on brick cylinders. The floor of the regulator was finished, but it was necessary to postpone that of the lock.

At Gungara we were more fortunate. The foundations of the lock and the regulator here were built without much trouble, and the regulating bridge for the Mustagada canal close to it.

evening of the 24th we were at Assiout, where a halt of two days was made while I went to Cairo in order to explain matters to His Excellency Riaz Pasha and you. On the 27th we moved southwards again, and reached Armant on the 9th October. By the 14th October we returned to Cairo on board the Nazaratia, having been absent thirty-four days.

At the principal Mudirieh towns we had meetings, at which the Inspectors of Irrigation, the Mudirs, the Chief Engineers, and principal notables were present, and expressed their opinions as to the best means of diminishing the Sharàki and the most convenient time and method of discharging the basins.

At all points where it was convenient to descend, a descent was made, and excursions made into the interior to examine the conditions of the basins; most of the canals were gauged; the Mahgara Canals were examined; the means of irrigating and bringing the enormous durra crop to maturity were enquired into; local complaints were considered; the loss by evaporation and absorption was compared with the daily falling discharge of the Canals, so as to guide us as to the time of beginning the discharge (*sarf*) of the basins, and the method of conducting it; and the amount of water held up on the main basin regulators was measured.

The general conclusions to which we arrived were :

(*a*) While the Nile gauge at Assùan kept above 12 pics, a vigorous attempt should be made to keep the Syàlàs, or durra canals, clear. If the Nile fell below that gauge the fellaheen should be left to themselves, while every endeavour should be made to fill the borrow pits, hollows, and depressions of every kind, so as to store water for the durra crop. At the time of *sarf* all the Canals and borrow pits should be shut off, so that no water might escape from them.

(*b*) Depots of 20,000 sacks should be made at each of the three southern Mudiriehs so that the canal heads might be promptly shut off the moment the canals began flowing back into the Nile. All the steamers moving up and down the Nile should have 3,000 or 4,000 sacks each to aid in case of necessity.

(*c*) The landowners in the well filled basins, where there was a chance of sowing without ploughing, were anxious that the *sarf* should be delayed till the 10th October ; while the landholders in the dry basins, depending for their supply on the *sarf*, and in the badly filled basins, where ploughing would have to be resorted to, were anxious that the *sarf* should begin as early as possible after the *salib*, that is after the 26th September. We concluded that, in the interests of the State and of the general community, it was better that the well filled basins should be discharged early and be ploughed, than that millions of cubic metres of water should be allowed to evaporate, and the total area under crop be considerably reduced. This was the principle adopted everywhere except at the western boundary between the Kena and Girga Mudiriehs,

17. — Good progress was made on the lock and regulating bridge at Kafr Dawar on the Mahmoudieh canal. Here too we had to deal with bad foundations, and it was necessary to found the regulator on 12 brick wells. The contractor did his work exceptionally well.

A syphon was built under the Mahmoudieh canal at Zargon a few miles from Atfeh to serve for the drainage of the great triangle bounded by the canal, the Railway and the river Nile. The excavation of the drain itself awaits funds.

18. — This completes the works carried out under the million loan. I will now go on to notice the works carried out in the different Provinces from ordinary funds.

19. — *Kaliubieh, Sharkieh, and Dakahlieh.* — As in 1887, Mr. Garstin turned his attention chiefly to improve his drainage channels as shewn in the following table and his total of 615,778 cubic metres represents a great deal of work.

PROVINCE	DRAINAGE CHANNEL	LENGTH — Kilometres	EARTHWORK — Cubic metres	EXPENDITURE 1888
				L. E.
Sharkieh	Towehr....................	8	8,000	218
»	Bahr el Bagar..............	110	52,559	2,826
»	Um Shok...................	7	32,756	706
»	Bahr Harami...............	6.5	56,374	1,226
»	Bahr Battikh...............	8	29,348	842
Dakahlieh	Tanah Gabada..............	18	84,950	2,124
»	Bashmur....................	40	56,819	1,421
»	Nizam..	17	91,533	2,746
»	Tamai......................	11	117,559	2,939
»	Bahr el Kabir..............	18	85,880	2,147
»	Mansurah...........	44.5	...	89
		288	615,778	17,284

(*l*) If the Kena *sarf* could be received in time and in quantity sufficient to guarantee the irrigation of the 20,000 acres of Sharàki to the immediate north of Sohàg, a second temporary *sadd* should be thrown across the Sohàgia Canal at Naga Tamam Salîba, between the 12th and 20th October, and the water of the basins on the left of the Sohàgia allowed to irrigate the dry basins on the right of the Sohàgia Canal.

(2) *The probable amount of Sharàki in Upper Egypt.*

Having had no opportunity on our journey southward of inquiring into the state of the right bank basins and canals in Mudirieh Gisa, we at first sent no estimate of Sharàki; but having had an opportunity of examining the basins on our return to Cairo, comparing them with similar basins further south, and consulting the Inspector of Irrigation 3rd Circle, at Wasta, we calculate that the Sharàki will not exceed 8,000 feddans, and may fall to 2,000 feddans if the Kushèsha breach is a success.

Summing up all the information we have supplied at different times, the following table contains the estimated quantities of maximum and minimum Sharàki in Upper Egypt. The maximum amount of Sharàki represents the number of feddans of Sharàki if the measures undertaken to reduce the area are uniformly unsuccesful; while the minimum represents the quantity if the measures are uniformly successful.

Estimate of Sharâki in Upper Egypt.

RÉSUMÉ OF ORIGINAL ESTIMATES PREVIOUSLY SENT IN

MUDIRIEH	DETAILS	TOTAL AREA FEDDANS		PROBABLE SHARAKI IN FEDDANS			
				Maximum		Minimum	
		DETAILS	TOTAL	DETAILS	TOTAL	DETAILS	TOTAL
Gisa	Left bank......	133,000		...		...	
	Right bank. ..	48,000	181,000	8,000	8,000	2,000	2,000
Beni-Suèf	Left bank	239,000		...		...	
	Right bank....	4,000	243,000	3,000	3,000	2,000	2,000
Minia	Left bank	395,000		...		..	
	Right bank....	26,000	421,000	22,000	22,000	20,000	20,000
Assiout	Left bank	340,000		5,000		2,000	
	Right bank....	85,000	425,000	30,000	35,000	23,000	25,000
Girga	Sahel	30,000		10,000		10,000	
	Right basins..	49,000		20,000		15,000	
	Left basins, South of Sohag	117,000		60,000		30,000	
	Left basins, North of Sohag	120,000	316,000	60,000	150,000	20,000	75,000
Old Kena	Sàhel	45,000		20,000		15,000	
	Left basins, South of Heu..	54,000		9,000		4,000	
	Left baisins, North of Heu.	43,000		29,000		27,000	
	Right basins, South of Kena.	70,000		10,000		6,000	
	Right basins, North of Kena	63,000	275,000	12,000	80,000	8,000	60,000
Old Isna	Sahel	65,000		20,000		15,000	
	Leftbank basins	55,000		7,000		6,000	
	Right bank basins..........	15,000	135,000	6,000	33,000	6,000	27,000
Fayoum		...	220,000	...	...	...	...
TOTAL OF UPPER EGYPT...		...	2,216,000	...	331,000	...	211,000

Mr. Garstin has further spent L. E. 1,301 on the improveme of roads along his canal banks which are now in many places f for general traffic.

21. — The following is given by Mr. Garstin as the length canals and drains in the Eastern Provinces. Had the canals bee originally laid out on any scientific system the irrigation migl have been effected with a much smaller number.

PROVINCE OR LOCALITY	SEFI CANALS — Kilometres	NILI CANALS — Kilometres	DRAINS — Kilometres	TOTAL GOVERNMEN CHANNELS — Kilometres
Kalliubieh..	145	522	...	667
Ismailieh canal........	276	...	...	276
Sharkieh.............	1,762	352	152	2,265
Dakahlieh............	1,258	410	324	1,992
TOTAL....	3,441	1,284	476	5,201

Mr. Garstin estimated that during the *Seti* of 1888 each fedda of land required in Sharkieh 19.14, and in Dakahlieh 17.68 cub metres of water.

The following canal and river discharges measured about 18th June are of interest, the gauges up and downstream of Damietta Branch Barrage being 12.98, and 11.55.

Ismailieh canal.........	2,559,017	cubic metres per dier
Sharkawieh canal......	681,683	,, ,, ,,
Bassusieh canal	322,234	,, ,, ,,
Bahr Moes canal......	1,729,036	,, ,, ,,
Sahel canal	1,973,348	,, ,, ,,
Mansourieh canal.	1,685,332	,, ,, ,,
Um Salama canal......	1,590,344	,, ,,
Total discharge irrigating the Eastern Provinces...	18,184,080	,, ,,
Discharged down stream...	[illegible]	,, ,,

might use his influence with the Mudirs to induce them to attend promptly to the demands of the Engineers. His Excellency's efforts in aiding us were very successful.

In conjunction with the Inspectors of Irrigation and the Chief Engineers, we investigated the points where *hoshas* were necessary, and encouraged the Mudirs to quickly construct them ; carefully examined the Tàrif and Dendera Mahgara canal clearances ; divided the left bank basins into the following sections (a work which we trust will result in some reduction of Sharàki) :

1st *Section.* — Ramadi Head to Hêu. The escape water to go down the *sarf* canal and irrigate the Sahel Farshût.
2nd *Section.* — Hêu to Sohàgia Head.
3rd *Section.* — Sohàgia Head to Assiout.
4th *Section.* — Assiout to Abu Kadîga.

We aided at the construction of the first Sohagia dam and afterwards supervised the distribution of the discharge of 16,000,000 cubic metres per day. The Kena *sarf* being late and it being also necessary to keep the Sohagia canal open to complete the irrigation of Beni Smia basin, we were unfortunately able to do nothing for the second dam.

We explained your directions about the non-closing of the first regulators to all the Engineers and met with success everywhere except in Girga, where the Mudir interfered with the Engineers, with the result that there were some 10,000 acres of quite needless Sharàki.

(4) *The necessary measures to be taken to reduce Sharàki in future years.*

Our work in this direction was of two kinds :

a) Obtaining information which will aid you to form conclusions of your own.

b) Forming definite conclusions of our own.

a) This information is contained in the letters and telegrams forwarded to you. I append a few of the local opinions about agricultural matters in the three southern Mudiriehs.

Kena and Girga Mudiriehs finishtheir irrigation in an ordinary year in twenty-five days.

Girga and Assiout Mudiriehs finish their irrigation in an ordinary year in thirty days.

Water should not be permittedd to enter any basin before the 1st Misra (6th August).

If an irrigated basin is dry before the first Tût (10th September) it is Sharàki.

If an irrigated basin is dry before the 17th Tût (26th September) it will yield a poor crop.

The 1st Tùt (10th September) is the feast of Nèrùz.

The 17th Tùt (26 September) is the *salib* of the Nile.

Sarf cannot begin before the *salib*, that is before the 27th September.

The best date for *sarf* is ordinarily 1st Bàba (10th October).

Lòk sowing begins generally on 8th Bàba (17th October).

If *sarf* is delayed after the 20th Bàba (29th October) the crop will be damaged.

b) The definite proposals we make are the following:

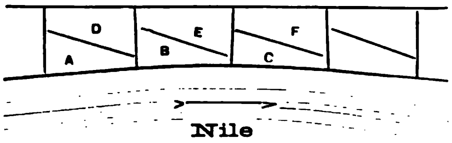
(I) General;

(II) Particular.

b) (I) *General*. — Where possible, the construction of a few big canals cleared to a nine pic (Assùan) bed, of the Rammàdi type, instead of as at present many small canals cleared to a 10 and 10 ½ pic bed. The Fadalia, Rannàn, and Kasra might be thus treated.

The obliteration (if possible) of basin canals cleared to an eleven pic bed.

The preservation of the small basins along the Sahel of the Nile. These small basins are very skilfully placed as shown in the accompanying sketch, so that the water in D can be utilised for B, and that of E for C. It is this arrangement of the smaller basins which made the Sohagia *sadd* a success. The absorption of these smaller basins into the larger basins causes the joint basin to fill to a great depth before the whole land is covered; with the result, that much valuable durra crop is drowned out every year, that the waves are much more severe, and in a year like this water cannot be economised.



Every canal should have near its head a dry stone platform to the exact section of the canal with its bed at the proper level, 9, 9 ½ or 10 pics to which the canal should always be cleared. The canals cleared by level have not silted up much this year and have been invaluable for keeping alive the durra crop on them.

Directions about non closures of first Regulators when the Assuan gauge is below 13 ½ pics, and other similar matters treated in the first section might be printed and circulated among the Engineers.

The devotion of a larger proportion of the L. E. 250,000 Corvée Relief grant to the two southern provinces Kena and Girga than has hitherto been the practice.

For the right bank basins in Mudirieh Girga, the existing canals of each series of basin should be prolonged into the last basin of each series. The canals are too short for a low year.

b) (II) *Particular*. — Great part of the legitimately unavoidable Sharàki lies concentrated at a few points. Special measures for these places are recommended.

Mudirieh Kena. — Rannàn Head to Samhûd 30,000 feddans Sharàki.
To remedy this Sharàki the following works are recommended:

1. — A Regulator and escape at Salîba Dendera — L. E. 5,000.

2. — The thorough clearance of the Mahgara Dendera canal and providing it with berms and slopes of $^1/_1$, so that sand may not destroy the lands to be irrigated by this canal — L. E. 20,000.

3. — The Rannàn to be made a canal of the Ramàdi type.

4. — The *sarf* canal to be connected with the Rannàn canal.

Mudirieh Girga. — Balyàna to Sohag — 40,000 feddans Sharàki.

1. — Of this area 20,000 feddans would be out of danger if the Rannàn canal were made like the Ramàdi as proposed above.

2. — The construction of the Kasra canal into one of the Ramadi type.

3. — A Regulator under Birba Salîba — L. E. 5,000.

Mudirieh Girga. — Immediately north of Sohàg — 20,000 feddans.

Sharaki.

1. — The construction of a syphon under the Sohagia head to take water from the left to the right — L. E. 15,000.

2. — The construction of a syphon under the Umlèla — L. E. 4,000.

Mudirieh Girga. — In the vicinity of Tahta — 45,000 feddans Sharaki. — (This was saved this year by the temporary *sadd*).

1. — Regulator at the 35th kilometer of the Sohagia — L.E. 20,000.
In conclusion I beg to state that if most of the important canals had not been carefully cleared by means of levelling, the amount of Sharàki this year would certainly have been double of what it actually is. Those canals which were evidently cleared without levels, have shown very bad results.

I have the honour to be,
Sir,
Your obedient servant,
W. Willcocks, M. I. C. E.
Inspector of Irrigation, 2nd Circle.

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I am sorry to say that I cannot accept this view of the case. The consequences shew that the Council and the Mudir were both wrong and that Major Brown, their technical adviser, was still more wrong, his error being shared by the direction of the Department in Cairo, whose representative he was and who tacitly approved of his action.

45. — Major Brown had never seen an exceptionally high flood until 1887, nor an exceptionally low flood until 1888. I think it undeniable that previous to 1887 he had not sufficiently considered that a flood such as had happened as lately as 1878 might happen any year again, and that as he himself express it he had allowed the banks to "become gradually degraded and too low". — I think it equally undeniable that previous to 1888 he had failed to realize that such a failure of the flood as had happened as lately as 1877 might happen any year again, and that he had not taken sufficient pains to silt-clear his canals. Year by year he had been employing the money and the labour at his disposal in effecting great improvements to his works, but he had not sufficiently remembered the first necessity of being provided against exceptional years by keeping his banks high enough to overtop extreme floods, and his canal intakes large enough and their channels clear enough to fulfil their purpose even with very defective floods. As Colonel Ross is preparing a special report on the working of the basin system of irrigation and measures to be adopted for its improvement, it is needless to enter into details on the subject here. It broke down more grievously in Girgeh than in any other Province.

46. — Major Brown bestows much attention on the state of repairs of his bridges. This year he put into thorough order the Kikhya and Sawalem bridges, and did repairs to 24 others in the Province of Assiout. He has also bestowed trouble and thought on the improvement of local roads year by year adding to the lengths

of road by levelling embankments and filling in cuts. He reports that the left bank of the Ibrahimieh canal for 30 kilometres north of Minieh is now a good road. The Western *Muhit* (or longitudinal embankment separating the basins on the west from the Ibrahimieh canal cultivation) is now a good unbroken road from Ashmun to Beni-Souef 138 kilometres. The central *Muhit*, an embankment running north and south through the middle of the *Sefi* irrigation is now a good road for 54 miles from Matai to the canal Sultani, north of Feshn.

Private individuals have built good wooden bridges across the Ibrahimieh canal at Mellawi, Magussa, and Samalout. The difficulty is to induce the natives to respect the roads and bridges made entirely for their own benefit. Across the former they think nothing of cutting deep ditches if it is the least help to their irrigation. The latter they destroy for the sake of the timber which they steal. Major Brown built four wooden bridges across drainage channels last year. In less than a year three of them had disappeared altogether, and part of the timbers of the fourth had been stolen.

47. *Keneh and Esneh.* — The new works done this year are N^{os} 32 to 35 of Table II, Appendix A. The regulating bridge in the Escape from the Gebelan Basin, Shansurieh series was begun last year and now is finished. The Rinan syphon which gave so much trouble as regards foundations in 1887 was also finished in 1888, although a charge of about L. E. 430 for pumping the foundations dry was not paid before the end of the year. Table IV gives the details of outlay on maintenance. Repairs were done to 19 indifferent masonry works.

48. — In previous reports I have noticed how slow the Corvée was to diminish in the Southern Provinces. I am glad to say 1888 shews an improvement here. There were 13,740 men employed for 100 days (see Table at para: 9). In 1886 there were 20,436

men employed. Compared with last year the quantities of work done have been as follows :

	CUBIC MÉTRES ESCAVATED	
	1887	1888
Corvée labour.........	2,107,339	1,672,262
Paid work...............................	1,058,810	2,073,561
	3,166,149	3,745,823

That is 55 per cent of the work was done by contract, and L. E. 27.461 was spent in these poor Provinces.

49. — The canals were opened between the 11th and 17th August, and the northern or lower basins of the various system were soon filled. Seeing that the flood was likely to be a poor one an unusually large area of *Nabari* crops (i. e. maize) was sown on the river's edge and the high parts of the basins.

The smaller canals had only been cleared enough to allow of their being filled by a 13 pic flood at Assouan. When it appeared early in September that the flood was to be a failure, 1,000 men were called out as Corvée in each district to deepen their canals and a good effect was produced. On 10th September the Escape regulators in the lower basins were shut so as to prevent any water from getting back to the river, and so the higher parts were partially watered.

50. — When the water was drawn off the basins, and there was no chance of a future rise, there were left in Keneh about 120,000 feddans *Sharaki* or unwatered. On about 20,000 of these feddans a winter crop was sown. The rest was left untilled. That a much larger area was not *Sharaki* after the flood of 1888 is due to the many improvements in the canals of Upper Egypt since 1884. Col. Ross spends some time every year in these Provinces, and the regularity introduced into the works, the superior style of silt

clearance done by contractors over the haphazard Corvée work, and the junction canals and new regulators, have all brought about a marked improvement.

51. — *Protection against Nile flood.* — The amount spent during 1888 on this heading was L. E. 63,497, a sum above the average and due to the mischief done to the embankments by the flood of 1887. It includes also a payment of L. E. 12,256 made to the State Railway in virtue of an arrangement come to, as to the protection of the line along the bank of the Ibrahimieh Canal in the Province of Assiout. If this sum be deducted we shall have left 51,241; while the average charge for the last four years has been L. E. 53,175.

The usual measures for Nile protection were taken in the other Provinces, but they represent nothing of special interest.

52. — I conclude this Report, as I have done in previous years, by mentioning the officers whose good services have come specially before me, or who have been brought to my notice. Lieut: Colonels Western and Ross have continued to assist me as heartily as in former years, and I think we all felt how well they had deserved the decoration (C. M. G.) which Her Majesty bestowed on them.

Lieut. Col. Ross had exclusive charge of the Irrigation Department from August to November, while I was absent in Europe.

Mess^rs Garstin, Willcocks, and Foster, Major Brown and Abou Saoud bey, all fulfilled their duties with zeal and ability.

Mr. A. G. Reid directed the works at the Barrage with the greatest order and precision.

Lieut. Col. Western brings the following officers to notice employed on the works of the million fund.

Mr. J. Dempster,
» F. Chanter, } *specially recommended.*
» G. Liernur Bey, }

Mr. Margossoff Bey,
» Kurshid Bey Wahabi,
» Mohammed Sidki Bey,
» P. Zoukas,
» J. Langley,
» W. O. Joseph,
» F. Chapman,
» I. Wakefield,
» H. Baychelier.

The following officers are also brought to favourable notice:

Mr. W. Marshall Hewat, Director of Works .... Fayoum.
» Allan Joseph, Assistant Inspector 1st Circle Irrigation »
» Arnold Perry, » » 3rd » »
» Ismaïl bey Sirri, » » 4th » »
» Mohammed bey Labib, Chief Engineer of the Nubarieh Canal.
» Barrière bey, Controller of the Pumps at Atfeh.

Mohamed bey Sabri...........	Chief Engineer,	Ismailiah Canal.
Ahmed bey Said.............	» »	Sharkieh.
Mohamed bey Zahir...........	» »	Menoufieh.
Hassan effendi Sherif,	Officiating Chief Enginer,	Gharbieh.
Abdul Wahab bey Zeki..........	Chief Engineer,	Rayah Behera.
Ali bey Burhan.................	» »	Behera.
Hassan effendi Wasfi...........	» »	Beni-Souef.
Mohamed bey Neghib	» »	Minieh.
Ali bey Badr..................	» »	Assiout.
Abdul Fattah bey Sabri..... ...	» »	Girgeh.
Hussein effendi Ragheb,.......	Assistant Engineer,	1st Circle.
Ali » Massaood......	» »	» »
Ahmed » Helmi.........	» »	» »
Hussein » Wassif........	» »	» »
Ali » Talab.........	» »	» »
Mohamed » Fahmi	» »	2d Circle.
Mohamed » Mohib........	» »	» »

Mohamed	effendi	Mungi	Assistant	Engineer,	2d	Circle.
Mahmud	»	Rifki	»	»	3rd	Circle.
Ali	»	Shauki	»	»	»	»
Mohamed	»	Labib	»	»	4th	Circle.
Hassan	»	Hidayat	»	»	»	»
Muhamed	»	Heshmat	»	»	»	»
Abdullah	»	Wahbi	»	»	»	»
Abdel Rahman	effendi	Wahbi	»	»	»	»
Yussuf	»	Sidki	»	»	»	»
Mohamed	»	Wafai	»	»	»	»

I owe the same gratitude as in former years to my friend and fellow worker Mr. Barois, Secrétaire général in the Public Works Ministry, and to Mr. Gallois bey, Head of the Technical Office. Mr. Peake, the Inspector of Public Works accounts renders cheerful assistance to every one. Farid bey Babazogli, Mohamed Derwish bey, Neghib bey Bahri, Mr. Olivier, and Ibrahim Mussawir effendi, Heads of the Office, have done their duty well.

C. C. Scott Moncrieff,
Under Secretary of State,
Public Works Ministry.

APPENDICES

APPENDIX A.

PUBLIC WORKS MINISTRY

IRRIGATION BRANCH — EXPENDITURE FOR 1888.

N°	NAME OF WORK	OUTLAY IN 1888	OUTLAY previous to 1st Jan. 1888	TOTAL OUTLAY	REMARKS
		L. E.	L. E.	L. E.	
	I. — The Million Fund.				
1	Barrage, Rosetta Branch.............	31,607	96,400	128,007	
2	» Damietta Branch............	109,038	...	109.038	
3	Rayahs Tewfiki-Earthwork......	80,654	127,750	208.405	
4	» Price of land..........	1,382	21,095	22,477	
5	» Head Regulator & Lock.	20,445	7,521	27,966	
6	» Two syphons...	5,287	2,852	8,139	
7	» Two small Regulators..	989	2,477	3,466	Finished
8	» Two Rail. swing Bridges	9,824	3,249	13,073	
9	» Bahr Moes Reg. and Lock	10,553	4,975	15,528	
10	» Gangara do. do.	8,076	...	8,076	
11	» Minor Works.........	406	1,967	2,373	
12	Mitghamr Regulator and Lock.	8,633	18,755	27,388	
13	Railway Bridge-Mansurieh canal	446	1,491	1.937	do.
14	Mansurah Lock......	3,763	22,565	26,328	do.
15	Kalangil Lock and Regulator.........	10,292	7,188	17.480	do.
16	Ananieh Creek syphon...............	..	1,225	1,225	do.
17	Damietta Reservoir..................	430	11,163	11,593	do.
18	Head Lock, Rayah Menoufieh.........	3,890	11,332	15.222	do.
19	Lock at Head of Bagurieh canal.......	5,521	7,442	12,963	do.
20	» Shubrabas on Bagurieh canal.	7,343	4,667	12.010	
21	Railway swing-Bridge, Dalgamun.....	1,800	1.100	2,900	
22	Kodaba Lock.....	1,801	6,339	8,140	
23	Santa Lock and Railway swing Bridge.	4,260	5,011	9,271	Bridge finished
24	Works on Bahr Saidi-Gharbieh	...	14,682	14,682	
25	Kafr Dawar Lock and regulator.......	9,730	2,684	12,414	
26	Syphon under Mahmudieh canal......	3,654	...	3.654	Finished
27	Rosetta canal	...	24,876	24.876	do.
28	Feshn syphon-Ibrahimieh canal.......	4,519	13.386	17.905	do.
29	Works in Tyur Basin-Fayum.........	...	4,504	4,504	do.
30	Wadi Rayan survey.................	368	497	865	do.
31	Minor Works Fayum................	1,248	...	1,248	do.
32	Mitrodeny syphon-Wadi canal	..	1,000	1,000	do.
33	Sundry Minor Works................	946	711	1,660	do.
	Establishment, travelling allowances, etc..	16.155	33,367	49,522	
	Tools and Plant.......................	5,990	15,389	21.379	
	TOTAL....	369,053	477,562	846,615	

IRRIGATION BRANCH — EXPENDITURE FOR 1888 *(continued).*

N°	DESCRIPTION OF WORK	TOTAL on earth work	TOTAL in Province	TOTAL in Circle
		L.E.	L.E.	L.E.
	II.— Ordinary Budget — Original Works.			
	Kaliubieh :			
1	Ismailieh canal — Minor Works to Locks ..	431		
2	Filfila canal — Land charges	2,704	3,135	
	Sharkieh :			
3	Alterations Abu Tabal Regulator..........	555		
4	» to canal heads, &c............	593	1,148	
	Dakahlieh :			
5	Iron drainage pipes	134	134	4.417
	Gharbieh :			
6	Works on Bahr Saidi....................	1.882		
7	Kantaret Usman Lock...................	342		
8	Salabib Lock............................	219		
9	Iron Drainage pipes, &c......	319	2.762	2,762
	Beherah :			
10	Garadat el Nakla Sluices..................	589		
11	Sluices and Earthwork — Khandak el Gharbi	872		
12	Syphon under Mahmudieh canal	485		
13	Regulator on Farhash canal.......... ...	434		
14	Head Sluice Khashabi canal.	271		
15	Kafr El Eis Project Earthwork........... .	[illegible]		
16	New canals in connection with above	572		
17	New Syphon do. do.	946		
18	Fasara Head Sluice..............	191	6,959	
	Gizeh :			
19	Nazra Basin Escape........................	755		
20	Minor Works..............................	568		
21	Completion of repair [illegible] yah Beherah Head.	250	1,573	

IRRIGATION BRANCH — EXPENDITURE FOR 1888 *(continued)*.

IV. — Expenditure on Maintenance of Works during 1888.

MOUDIRIEHS	ORDINARY BUDGET-TOTAL OUTLAY L.E. 117,101						CORVÉE RELIEF BUDGET (L.E. 250,000) SPENT L.E. 249,846							CORVÉE RANSUM FUND SPENT L.E. 74,050				GRAND TOTAL	
	Repairs to Masonry Work	Protection against inundation	Temporary Dam in Nile	Dredging Canals	Petty repairs surveying, etc.	TOTAL	Dredging	Earthwork in Canals and Banks	Clearance of Drains	Groynes in Canals	Temporary Dam in Nile	Petty charges	TOTAL	Earthwork in Canals and Banks	Clearance of Drains	Petty charges	TOTAL	FOR 1888	FOR 1887
	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.
Kallubieh.............	1,300	1,338	...	...	...	2,638	14,400	...	670	...	...	...	15,070	...	75	..	75	17.783	32,088
Sharkieh..............	255	453	...	...	...	708	13,600	...	8,400	...	...	...	22,000	9.814	2,075	75	11,964	34,672	18,255
Dakahlieh............	409	6,260	5,085	...	...	11,754	6,050	...	15,923	...	1,160	...	23,133	3,000	6,234	..	9,234	44.121	32,631
Barrages..............	5,614	...	...	...	...	5,614	...	...	...	...	2,075	...	2,075	...	...	..	...	7,689	12,596
Menoufieh............	3,496	3,509	...	...	...	7,005	...	18,111	...	...	...	...	18,111	12,493	...	..	12,493	37,609	31,500
Gharbieh.............	2,458	6,482	...	...	301	9,241	...	26,136	...	...	...	...	26,136	14,942	...	..	14,942	50,319	23,510
Beherah..............	1,839	4.567	4.908	...	...	11,314	8,398	3,887	1,345	...	6,751	444	20,825	...	...	248	248	32,397	32,545
Giseh.................	1,831	3,746	...	...	135	5,712	25,448	1,878	4,039	7,440	...	660	37,465	6,484	...	..	6,484	49,661	36,168
Fayoum...............	716	...	...	...	...	716	...	7,244	...	...	...	...	7,244	...	...	58	58	8,018	7,623
Beni-Souef...........	801	3,017	...	...	...	3,818	...	7,975	...	...	...	25	8,000	...	...	..	...	11,818	11,486
Minieh...............	630	1,359	...	...	...	1,989	...	9,975	...	...	...	25	10,000	1,129	...	..	1,129	13,118	11,704
Assiout...............	90	20,468	...	18,970	...	40.338	...	16,276	...	...	...	50	16,326	17,423	...	..	17,423	74,087	47.012
Girgeh................	516	1,047	...	...	60	1,625	...	15,950	...	...	...	50	16,000	...	...	..	...	17,623	19,413
Keneh.................	1,547	508	...	...	...	2,055	...	17,574	...	...	...	...	17,574	...	...	..	...	19,629	13,563
Esneh.................	618	323	...	...	...	941	...	9,887	...	...	...	...	9,887	...	...	..	...	10.828	7,586
Central Administration	...	10,035	...	...	1.600	11,635	...	...	...	...	...	...	...	...	...	..	...	11.635	3.200
Town Service Cairo....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	...	2,580
TOTAL L.E....	22.930	63.112	9.993	18.970	2.096	117.101	65.896	134 893	30.377	7.440	9.986	1.254	249,846	65.285	8,384	381	74.050	440.937	343.444

IRRIGATION BRANCH — EXPENDITURE FOR 1888 (*continued*).

V. — Amount of Earthwork executed in 1888 in the clearance of Canals and Drains, and the maintenance of embankments.

PROVINCE	WORK DONE BY CONTRACT			WORK done by Corvée	TOTAL WORK done by contract and Corvée
	Corvée relief Cubic Metres	Corvée ransom Cubic Metres	TOTAL Contract Cubic Metres	Cubic Metres	Cubic Metres
Kaliubieh.....	445,764	...	445,764	204,919	650,683
Sharkieh.....	643,502	579,598	1,223,100	...	1,223,100
Dakahlieh....	941,804	339,592	1,281,396	968,733	2,250,129
Menoufieh....	447,192	875,987	1,323,179	...	1,323,179
Gharbieh.....	1,638,651	810,535	2,449,186	270,537	2,719,723
Beherah......	664,086	1,500	665,586	354,072	1,019,658
Giseh........	690,715	478,579	1,169,294	290,546	1,459,840
Fayoum......	462,293	...	462,293	226,643	688,936
Beni-Souef....	520,390	...	520,390	649,256	1,169,646
Minieh.......	806,618	115,814	922,432	1,163,160	2,085,592
Assiout.......	1.015,571	1,190,324	2,205,895	1,119,617	3,325,512
Girgeh.......	1,103,447	...	1,103,447	1,973,555	3,077,002
Keneh & Esneh	2,073,561	...	2,073,561	1,672,262	3,745,823
Barrage......	...	...	...	...	...
	11,453,594	4,391,929	15,845,523	8,893.300	24,738,823

VI. — Payment to Behera Irrigation Society

FOR SUPPLY OF WATER IN THAT PROVINCE

	OUTLAY 1888	OUTLAY 1887
	L.E.	L.E.
Fixed annual sum..............................	26,320	26,320
Supply of water at Atfeh..................	16,159	10,073
» » Khatatbeh...................	18,776	17,458
TOTAL....L.E	61,255	53,851

APPENDIX B.

BARRAGE REPAIRS

REPORT ON WORKING SEASON 1887

During the working season of 1887 the floor of the western part of the Rosetta Barrage had been laid dry and repairs to it carried out as far as the early rise of the river allowed.

It was originally intented that the eastern part of the same Barrage should be put in order during the season of 1888 so as to complete one bridge before commencing another.

The extreme height however of the Nile in the flood of the previous year rendered, a late fall probable, and the obstruction of the deep channel of the Rosetta Branch became therefore inadvisable.

An additional argument in favor of taking up the east end of the Damietta Barage existed in the necessity for putting in the foundations of the Rayah Tewfiki Head Lock and Regulator, and as this work is adjacent to the river, the laying dry of a large area of the river bed immediately outside its foundation pit would result, it was thought, in an economy of pumping.

Yet a third argument existed in the need for completing a portion of the downstream apron of the west end of the Rosetta Barrage, and for strengthening the lock at that end: both of these works having been interfered with by the early rise of the river in 1887.

These arguments determined that the eastern end of the Damietta Barrage should be taken up in 1888, and accordingly on December 1st 1887 work was commenced on the dams.

The scheme of the work was identical with that carried out on the Rosetta Barrage during the previous year, both as regards the work itself and the manner of execution. The area to be dealt with was enclosed within double dams, those upstream having their crests at R.L. 14.50, and those downstream at 12.50. The former were made in water from 3 ms. to 7.5 ms. deep,of clayey silt dug from the island upstream of the Damietta Barrage, and proved to be very tight. The latter were made from the silt deposited yearly under the western arches of the bridge, and during the progress of the work they gave much trouble and anxiety.

On February 10th the upstream dams were closed, on February 17th the placing of the pumps in position was begun, and on February 25th fires were lighted.

As at first constructed the *sadds* enclosed 35 arches, and the area being too large to work at, it was subdivided into three portions by small *sadds* running parallel to the course of the river.

One only of these pockets was pumped down to floor level at a time, the water in the others being kept at different levels so as to reduce to a minimum the pressure on each dam.

On March 9th the floor of the 15 eastern arches was laid dry and work was at once begun. It was pushed on with vigor and continued without intermission until June 20th, by which time the floor of 41 arches and of the east lock had been put in order.

The condition of the Bridge was much better than that of the Rosetta Barrage, but this seems to have been due solely to the fact that it had not been subjected to the same strain.

The evidences of scamping were greater than any found on the Rosetta, and the failure of the work, if it had been left unrepaired, could only have been a matter of time.

The east lock was found to have small holes in its floor over the whole area, downstream of the lift wall and immediately at the foot of the lift wall no floor existed over an area of 7 ms. by 5 ms., nor could any trace of one be found at the depth of a metre below surface level. It was accordingly decided to raise the floor of the lock with cement concrete faced with brick on end and ashlar, the whole thickness so added being 0,72 ms. The small holes were first closed with wooden plugs and the new face then carried over them. Immediately below the lift wall the area without original foor was enclosed by a brickwall built in cement to a height of 2 metres. At this height it was found that the springs worked with insufficient force to throw mud, and so the whole area was excavated by divers to a depth of one metre and concreted over, each spring being enclosed in a pipe.

When set the pipes were closed and the new floor built to minimum thickness of 1.8 metres sloping upwards near the lift wall 1 in 7 to a thickness of 3.3 metres. The necessary thickness of floor was thus gained by the substitution of a slope for the vertical lift wall, and danger to boats by their grounding on a floor of sudden variation of level was obviated.

On the floor of the bridge itself several singular points were brought to light. Under many of the arches and in the floor downstream of them numerous holes existed.

They were caused by the omission of one brick on end, and from the freedom with which many of them threw water, they appeared to pass completely through the floor. They were in rows regularly spaced and resembled weepholes. Some of them were silted up so as to be quite water tight, whilst others threw a full bore of mud and water to a height of nearly two feet. Under arch N° 71 and in the floor downstream of it there were 37 of these holes and between three and four hundred in the 41 arches dealt with. They were each closed by driving in a wad of tow with a tapered wooden plug. When home the plug was sawn off level with the floor and covered with rubble masonry laid in cement.

Arches N^os^ 37 and 38 were found to have no floor. The concrete of the foundation appeared to have been skipped in and left at a level of about .5 metre below floor. The top of this concrete was rough and of very bad quality, the mortar and the metal having separated and formed into strata and pockets like a much disturbed geological formation.

It was leveled down and all very bad portions were removed to as great a depth as was possible with safety. New work was then built to a thickness of 2.25 ms.

The *sadds* as originally constructed enclosed 34 arches only. As work progressed new dams were thrown out so as to enable the repairs to be carried past the centre arches leaving so little work undone as to make the completion of the bridge as far as possible a certainty in one more working season. These extensions as before stated enabled the eastern 41 arches together with the end lock to be put in order.

The work done was as follows:

The whole of the existing floor of the Barrage both upstream and downstream as well as under the arches was raised from R. L. 8.25 to R. L. 9.5 with the exception of arches 70 and 71 which, owing to the badness of their floors, were raised to R. L. 10. This was done as on the Rosetta Barrage with concrete in cement faced for a length of 7 ms. under the gates with Trieste stone ashlar and elsewhere with ashlar of old Cairo stone. This new floor was carried upstream and downstream beyond the arches to the limits of the original floor. An upstream apron of rubble masonry 25 ms. wide and 1 m. thick was added, a row of piles being driven at 5 ms. within its upstream edge to a depth of 5 ms. below its underside. On the downstream side an apron was also built. Its thickness was 1.5 ms. and its width 10 ms. from arches 42 to 71 inclusive whilst from 31 to 42 the width was increased to 15 ms. and the thickness to 2 ms. on account of the badness of the soil.

The lockwalls both upstream and downstream were protected with an apron 12 ms. wide sloping from R. L. 12.0 at the wall to R. L. 9.5. Along the whole of the downstream edge of the floor, and at a distance from it of 5 ms., a row of rubble masonry blocks was built, each block being 5 ms. by 3 ms. by 1.5 ms., the space between this row of blocks and the edge of the floor being filled in with dry stone pitching covered with a layer of rubble blocks 2.5 ms. square and .75 m. thick. Beyond the outer line of blocks pitching was put in wherever there was place for it up to the level of the floor.

During the execution of this work the greatest sources of trouble were the original lines of piles between which the floor had been built. As on the Rosetta Barrage these piles had been left projecting about 1 metre above the top of the floor, and from end to end of the work done they formed an almost unbroken line of springs. Driven as they were through the upper stratum of clay into the underlying mud and sand and left projecting high into the rush of the water the downstream line of piles seemed to have been shaken loose and each separate pile became a lead for an upward rush of water. The shutting down of this water proved very troublesome, particularly in the centre of the river. It was effected by enclosing each separate jet in a pipe of suitable size surrounded with masonry.

When the masonry had set the pipes were closed and built over. Downstream of arches N^{os} 34 and 35 in a length of 14 metres 59 pipes were used, two being 12 in: diameter, three 6 in:, and the remainder 1 in: to 3 in:. The soil at this part of the Barrage was very bad, and this added considerably to the difficulty of the work, as a spring when stopped at one spot invariably broke out at others. So soft in fact was the soil at the middle of the Barrage that every blow of the pile-drivers working upstream was plainly felt on the bridge.

The work was completed by June 20th, and on June 25th, the last pump was removed. The quantities of work actually done were: Concrete 7,788m^3, Rubble Masonry 15,867m^3, Trieste Ashlar 541m^3, Old Cairo Ashlar 2001m^3, and Brick work 396m^3 or 26,593m^3 in all.

Iron grooves were added to the piers of the 41 arches, and a curtain of sheet piles was driven parallel to the upstream face of the bridge. The gates of the east lock also were put in order and painted.

The unwatering was a heavy item. It was done by nine 12 in: and three 10 in: centrifugal pumps. A 9 in: pulsometer kept down the water between the two upstream *sadds*, whilst two 4 in: pulsometers on wheels and numerous hand pumps were employed on drying small areas.

The pile driving was mostly done by hand ringing engines. A steam driver was however put to work when about one half the piling was finished, and it was found to send the piles home at about one third the cost of the hand drivers.

The electric light was started on February 26th and was employed without intermission until the end of the work. Although but little concrete or masonry was done at night, a great deal of work went on in maintenance of dams, carriage of materials from the stacking yard to the site, and, in general, preparations for the following day. One Assistant Engineer and one Head Overseer were invariably on the works all night, and the number of workmen employed at night from the beginning [illegible] till the end of May was never less than 800 and often rose to [illegible]

On the Rosetta Barrage same work was also done. As was stated at the commencement of this report a portion of the apron downstream of the arches 56 to 61 was not carried to its full extent during the working season of 1887, nor was the lower floor of the west lock put in order.

To remedy this a *sadd* was run along the ten western arches upstream of and in contact with the piers, and a corresponding dam was carried parallel to it downstream of the bridge at a distance sufficient to enable the work to be done. These two were joined by a dam parallel to the direction of the stream and the included area was then pumped out.

The whole area was covered with rubble masonry as intended, the springs which had given considerable trouble during the previous year were closed, and the apron downstream of the western arches was satisfactorily completed. The floor of the lock was laid dry and was found not to be in a bad state except at the tail. There a double line of sheet piling extending across it up to the level of the upper floor closed completely the lock as a low river one and served as leads for numerous springs. These piles were cut away and built over the level of the floor being raised from 8.15 to 9.00. An apron 10ms. wide was also carried across the tail of the lock and round the lock wall to meet the apron of the bridge. During the progress of the work some anxiety was caused by the cracking of the lock wall due to the removal of the soil on which it was built by heavy springs. 2.676m^3 of rubble masonry were laid in thus completing the floor of the west end of the Rosetta Barrage.

The bridge itself had originally failed owing to the break up of the floor, and this failure manifested itself on the superstructure by cracking in 10 arches and by depression and horizontal displacement extending over a length of 15 spans. Each year when the water was headed up these cracks enlarged, and when the work was taken up by this service, five of the arches had been centred up to prevent chance of accident. The vertical settlement amounted at that time to .15^m at its greatest point, the horizontal displacement being .19^m. During the progress of the work it was found necessary to put centres in five additional arches, as they cracked so badly as to place the men working below in danger from falling bricks. On attempting to remove the centres it was found that many of the bricks of the arches were completely loose and the repair of the arches themselves was necessary. In fixing the centering each lagging had been wedged off the centres separately and could therefore be removed independently of any other.

In carrying out the repairs one lagging was removed at a time, and if the arch behind it was sound, it was replaced and again wedged up. If a crack was uncovered it was raked out and pointed. Where a badly broken portion of the arch was uncovered it was removed in parts and rebuilt from below to a depth of one and a half bricks. In every case the lagging was replaced as soon as the work was done. When an entire arch had been thus treated the earth-filling and backing were removed and all cracks and broken brickwork opened out and rebuilt from above, down to the top of the new work put in from below.

When the whole of the arches were finished they were allowed one month to set and the centres were then removed.

No sign of any settlement has since shown itself. Ten pairs of the new gates were put in place, and the arrangement of tramway intended to carry the traveller for working these gates was put up over twenty bays. 288^{m3} of Brickwork, 65^{m3} of Ashlar masonry, and 117 tons of ironwork were erected for this purpose. A traveller of the design proposed for working the gates was obtained and found to work satisfactorily.

(Signed): A. G. REID.
Director of Works Barrage.

April 17th 1889.

evening of the 24th we were at Assiout, where a halt of two days was made while I went to Cairo in order to explain matters to His Excellency Riaz Pasha and you. On the 27th we moved southwards again, and reached Armant on the 9th October. By the 14th October we returned to Cairo on board the Nazaratia, having been absent thirty-four days.

At the principal Mudirieh towns we had meetings, at which the Inspectors of Irrigation, the Mudirs, the Chief Engineers, and principal notables were present, and expressed their opinions as to the best means of diminishing the Sharàki and the most convenient time and method of discharging the basins.

At all points where it was convenient to descend, a descent was made, and excursions made into the interior to examine the conditions of the basins; most of the canals were gauged; the Mahgara Canals were examined; the means of irrigating and bringing the enormous durra crop to maturity were enquired into; local complaints were considered; the loss by evaporation and absorption was compared with the daily falling discharge of the Canals, so as to guide us as to the time of beginning the discharge (*sarf*) of the basins, and the method of conducting it; and the amount of water held up on the main basin regulators was measured.

The general conclusions to which we arrived were :

(*a*) While the Nile gauge at Assùan kept above 12 pics, a vigorous attempt should be made to keep the Syàlàs, or durra canals, clear. If the Nile fell below that gauge the fellaheen should be left to themselves, while every endeavour should be made to fill the borrow pits, hollows, and depressions of every kind, so as to store water for the durra crop. At the time of *sarf* all the Canals and borrow pits should be shut off, so that no water might escape from them.

(*b*) Depots of 20,000 sacks should be made at each of the three southern Mudiriehs so that the canal heads might be promptly shut off the moment the canals began flowing back into the Nile. All the steamers moving up and down the Nile should have 3,000 or 4,000 sacks each to aid in case of necessity.

(*c*) The landowners in the well filled basins, where there was a chance of sowing without ploughing, were anxious that the *sarf* should be delayed till the 10th October; while the landholders in the dry basins, depending for their supply on the *sarf*, and in the badly filled basins, where ploughing would have to be resorted to, were anxious that the *sarf* should begin as early as possible after the *salib*, that is after the 26th September. We concluded that, in the interests of the State and of the general community, it was better that the well filled basins should be discharged early and be ploughed, than that millions of cubic metres of water should be allowed to evaporate, and the total area under crop be considerably reduced. This was the principle adopted everywhere except at the western bounda[illegible] and Girga Mudiriehs.

where the unanimity of the Kena officials and notables prevailed over the discord between the Girga officials and notables, with loss to Girga Province and no advantage to Kina Province as far as area was concerned. The day after the meeting we perceived how disastrous it would be to delay the *sarf*, and the Minister sent me specially to Cairo to get the Council of Ministers to repair the damage, and change the date of Sarf from October 10th to October 1st; but our advice was not taken by the Council of Ministers. The result was that on the 29th September the Girga basins had to begin their *sarf* (as they were fast drying up and could not wait till the 10th October) and great part of the Kena basin water was lost.

(*d*) Your directions about keeping the first bridges on the canals (when situated at less than 20 kilometres from the heads of the canals) open, and allowing the water to collect in the second basins of the series, should be rigidly adhered to; except where the canals had good banks in the first basins. Such canals could have their first bridges closed for ten days about the middle of September, while afterwards the openings in the banks could be closed and the water retained in the first basins, when the first bridges could be opened and the canals allowed to run into the second basins without emptying the first basins.

(*e*) The irrigation of those series of basins, where certain basins were well filled and the rest dry at the beginning of *sarf*, was more satisfactory than the irrigation of those series, where all the basins were partially filled and all dried up before the *salib* (September 26).

(*f*) Your idea of forming reservoir basins to keep water for *sarf* up to the 10th November at certain convenient points should be adopted at one basin as the experiment. The Umdehs of Kena and Girga agreed to select the basin Faukibly, suggested by you; and the experiment is now being made.

(*g*) The Dendera and Tarif Mahgara canals should be thoroughly cleared and repaired, and rendered as efficient as possible.

(*h*) All *hosha* banks should be thoroughly repaired and temporary *hoshas* (or *howâshes*) made wherever possible, so as to economise water at time of *sarf*.

(*j*) We were also entirely in accord with you on the subject of dividing the basins into sections and discharging each section independently of the others as it enabled the *sadd* to march slowly instead of being hurried on. The depth of water in the basins was so small that no velocity of any kind could be counted on, at time of *sarf*; and hurrying the discharge from basin to basin would have been about as useful as letting the basins dry up as they stood.

(*k*) Since the Sohâgia canal had been able to irrigate only very partially the basins in Girga Mudirieh, a temporary *sadd* should be thrown across it near the Anèbis Saliba, south west of Tahta, between the 20th and 28th September, and the water of the canals allowed to flow over the basins, thus saving between 40,000 and 50,000 feddans from Sharâki.

(*l*) If the Kena *sarf* could be received in time and in quantity sufficient to guarantee the irrigation of the 20,000 acres of Sharàki to the immediate north of Sohàg, a second temporary *sadd* should be thrown across the Sohàgia Canal at Naga Tamam Salîba, between the 12th and 20th October, and the water of the basins on the left of the Sohàgia allowed to irrigate the dry basins on the right of the Sohàgia Canal.

(2) *The probable amount of Sharàki in Upper Egypt.*

Having had no opportunity on our journey southward of inquiring into the state of the right bank basins and canals in Mudirieh Gisa, we at first sent no estimate of Sharàki; but having had an opportunity of examining the basins on our return to Cairo, comparing them with similar basins further south, and consulting the Inspector of Irrigation 3rd Circle, at Wasta, we calculate that the Sharàki will not exceed 8,000 feddans, and may fall to 2,000 feddans if the Kushèsha breach is a success.

Summing up all the information we have supplied at different times, the following table contains the estimated quantities of maximum and minimum Sharàki in Upper Egypt. The maximum amount of Sharàki represents the number of feddans of Sharàki if the measures undertaken to reduce the area are uniformly unsuccesful; while the minimum represents the quantity if the measures are uniformly successful.

Estimate of Sharâki in Upper Egypt.

RÉSUMÉ OF ORIGINAL ESTIMATES PREVIOUSLY SENT IN

MUDIRIEH	DETAILS	TOTAL AREA FEDDANS		PROBABLE SHARAKI IN FEDDANS			
				Maximum		Minimum	
		DETAILS	TOTAL	DETAILS	TOTAL	DETAILS	TOTAL
Gisa	Left bank......	133,000		...		...	
	Right bank. ..	48,000	181,000	8,000	8,000	2,000	2,000
Beni-Suèf	Left bank	239,000		...		...	
	Right bank....	4,000	243,000	3,000	3,000	2,000	2,000
Minia	Left bank	395,000		...		..	
	Right bank....	26,000	421,000	22,000	22,000	20,000	20,000
Assiout	Left bank	340,000		5,000		2,000	
	Right bank....	85,000	425,000	30,000	35,000	23,000	25,000
Girga	Sahel	30,000		10,000		10,000	
	Right basins..	49,000		20,000		15,000	
	Left basins, South of Sohag	117,000		60,000		30,000	
	Left basins, North of Sohag	120,000	316,000	60,000	150,000	20,000	75,000
Old Kena	Sàhel	45,000		20,000		15,000	
	Left basins, South of Heu..	54,000		9,000		4,000	
	Left baisins, North of Heu.	43,000		29,000		27,000	
	Right basins, South of Kena.	70,000		10,000		6,000	
	Right basins, North of Kena	63,000	275,000	12,000	80,000	8,000	60,000
Old Isna	Sahel	65,000		20,000		15,000	
	Left bank basins	55,000		7,000		6,000	
	Right bank basins.........	15,000	135,000	6,000	33,000	6,000	27,000
Fayoum		...	220,000	...	...	...	...
TOTAL OF UPPER EGYPT...		...	2,216,000	...	331,000	...	211,000

In Mudirieh Girga there has been a reduction of Sharàki of about 45,000 acres owing to the success of the first *sadd* on the Sohagia canal, and the maximun Sharaki may now be considered as about 285,000 feddans. Since the Kena water has not been received in time a possible improvement of 25,000 feddans must be abandoned and the minimum Sharàki may be taken as 240,000 feddans. Taking the mean of the two figures the probable Sharàki may be considered as 265,000 feddans with some contingencies for the unprecedented rate of fall of the Nile.

So far we have considered the Sharàki, we now come to the durra crop. The roughly estimated amount of durra sown in Isna, Kena, Girga, and Assiout is as follows:

Isna.........	40,000	feddans,
Kina........	80,000	»
Girga.......	60,000	»
Assiout......	40,000	»
	220,000	feddans.

The durra was sown late, owing to the flood being late. It was irrigated with a single Shadoof lift up to the 1st October, when the double Shadoof lift began. At the present rate of fall of the Nile it will be necessary to resort to the third lift on the 20th October. Besides this, all the Syàlas became dry about the 25th September, and though much clearance work was done, the rapid fall of the Nile defeated all efforts, and from the 5th of October no further efforts were made to clear Syàlas, but the fellaheen were left to themselves. Much durra far away from the Nile and from canals is in danger, and without exageration of any kind it may be stated that $^{1}/_{10}$ of the Kena and Isna crop and $^{1}/_{6}$ of the Girga and Assiout crop, or 30,000 feddans in all, are in a precarious condition. The durra will need water, not till the 15th October, as anticipated, but until the 30th October, and its safety depends only on the tenacity of the fellaheen themselves.

Against this possible loss of durra may be put the fact that very many of the Sharàki basins have excellent subsoil water, and well informed persons have told me that a large proportion of such basins will be put under winter crops irrigated from wells, and will be rescued from Sharàki.

Land rents in the three southern Mudiriehs have gone up about fifty per cent, and large landholders will not lose much from the partial drought. Some think they may gain, even where a large proportion of their land is Sharàki. The small landholders in the Sharàki basins will suffer severely.

(3). — *Steps taken to reduce the Sharàki.*

One of the first steps we took was to keep His Excellency Riaz Pasha accurately informed of the state of affairs and the requirements of Corvée, so that he might use his influence with the Mudirs to induce them to attend promptly to the demands of the Engineers. His Excellency's efforts in aiding us were very successful.

In conjunction with the Inspectors of Irrigation and the Chief Engineers, we investigated the points where *hoshas* were necessary, and encouraged the Mudirs to quickly construct them; carefully examined the Tàrif and Dendera Mahgara canal clearances; divided the left bank basins into the following sections (a work which we trust will result in some reduction of Sharàki):

1st *Section.* — Ramadi Head to Hèu. The escape water to go down the *sarf* canal and irrigate the Sahel Farshût.

2nd *Section.* — Hèu to Sohàgia Head.

3rd *Section.* — Sohàgia Head to Assiout.

4th *Section.* — Assiout to Abu Kadîga.

We aided at the construction of the first Sohagia dam and afterwards supervised the distribution of the discharge of 16,000,000 cubic metres per day. The Kena *sarf* being late and it being also necessary to keep the Sohagia canal open to complete the irrigation of Beni Smia basin, we were unfortunately able to do nothing for the second dam.

We explained your directions about the non-closing of the first regulators to all the Engineers and met with success everywhere except in Girga, where the Mudir interfered with the Engineers, with the result that there were some 10,000 acres of quite needless Sharàki.

(4) *The necessary measures to be taken to reduce Sharàki in future years.*

Our work in this direction was of two kinds:

a) Obtaining information which will aid you to form conclusions of your own.

b) Forming definite conclusions of our own.

a) This information is contained in the letters and telegrams forwarded to you. I append a few of the local opinions about agricultural matters in the three southern Mudiriehs.

Kena and Girga Mudiriehs finishtheir irrigation in an ordinary year in twenty-five days.

Girga and Assiout Mudiriehs finish their irrigation in an ordinary year in thirty days.

Water should not be permittedd to enter any basin before the 1st Misra (6th August).

If an irrigated basin is dry before the first Tùt (10th September) it is Sharàki.

If an irrigated basin is dry before the 17th Tùt (26th September) it will yield a poor crop.

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REPORT

OF THE

ADMINISTRATION OF THE DEPARTMENT OF IRRIGATION

FOR

THE YEAR 1889

BY

LIEUTENANT-COLONEL JUSTIN C. ROSS, C. M. G.
INSPECTOR GENERAL OF IRRIGATION, EGYPT

CAIRO
NATIONAL PRINTING OFFICE
1890

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CHAPTER I.

Basin Irrigation 1889.

Extent of Basin Irrigation in Egypt.

1. — The Basin Irrigation on the Pharaonic Lines extends on both Banks from Aswân to Derut; kilo 945—kilo 317 of Nile.

From Derut to Ashmant 317 to 96 kilom. the *Sefi* Irrigation of the Ibrahimiyah prevents inundation on the High Alluvial deposit called the *Sâhil* on the West or left bank.

The Basin Irrigation is again found on both banks from Ashmant to Cairo and it ends on the West at the Hod El Iswid about 30 kilometres below Cairo. On the East below Cairo, there is practically no basin irrigation. One small basin North of Kaliub still exists. It is maintained thus owing to the absence of any summer canal in the vicinity.

Sugar Factories in tracts under Basin Irrigation.

2. — In Upper Egypt there are the sugar factories of Mataanah, Armant, Dubaiyah, Naga Hamadi with the Farshut Sahil under peasant-cultivated sugar; Geziret El Salamîyah and small amounts of engine watered sugar cane near Balianah. In these tracts basin irrigation is very partial.

The flood of 1889. Its height and results.

3. — *Quality of flood.* — The flood was one of the best on record; all are agreed that it was very muddy. This fact combined with the feebleness of the flushes in September leads us to suppose that the White Nile was feeble in volume, but the absence of gauges at and above Khartûm renders this a matter of speculation.

The September flood was exactly enough for irrigation of the millet crops by flow irrigation, and if it had risen 20 centimetres more the crops on the edge of the river must have been drowned or ruined by filtration.

The crops were all matured, and as there was a very large area sown in Sorgho and Maize, the Fellahîn have been able to refill their granaries exhausted by the failure of the 1888 Spring harvest, owing to the low flood of 1888.

Time of filling and reduction of water.

4. — The basins of Upper Egypt were all filled by the 16th of September except the very largest. But owing to the increased number of escapes there were only three breaches in the basins. The reduction of the water in the case of those basins which were filled too full was effected with great skill by the local Engineers.

The Western chain of Basins in Middle Egypt.

5. — The Western basin chain of Middle Egypt was not however well filled as the feeders are not nearly sufficient to fill them, and the Ibrahimiyah does not give nearly enough water even in a good Nile like that of this year to fill this enormous chain.

The Gizah chain of Basins.

6. — The Eastern and Western Gizah chain was well kept in hand and there were no breaches.

The Emptying of the Basins Aswan to Suhag.

7. — The Sarf or emptying of the basins was commenced as usual about the 29th September and conducted without cutting the banks save where there are no regulating bridges in the Kena circle. The large quantity of water in the Samhûd basin could not be passed off by an artificial cut into the Nile and therefore the cross bank had to be cut and the water discharged on to Hod Bardis. This upset the South Suhâg series and caused sundry cuts to be made. The great cut at Suhâg was made on October 1st to empty the Suhâg Basin and the large chain to the South with a head of 2.06 on to the Nile. This great cut took 88,000 m^3 earthwork to mend. This is the last time the cut will be made as the new escape of 12 arches has been completed this year.

Series North of Suhag.

8. — In emptying the next series to the North (the North Suhâg) there was some error made by the Chief Engineers of Asyut and perhaps of Girga. The cut of Beni Samiâ was made on 12th October on to the river and between that date and the 21st the Mudir of Asyut wrote and telegraphed to the Ministry of the Interior that the water was not flowing off from Hod ez Zannar the last basin of the chain and on the 22nd of October finding that the Hod ez Zannar was 1.70 above the river notwithstanding that its bridges had been open for three weeks, a cut was made in its banks on to the Nile. The Mudir of Asyut deserves credit for having so persistently called attention to the short comings of the local Chief Engineer.

Bahr Yusif Basins.

9. — Again notwithstanding very clearly written instructions of Major Brown's, the Bahr Yusif was so reduced in volume, when the Dalgawi basin was cut, that it was only by the exertions of the Chief Engineer of Minya that the catastrophe of thousands of acres of *sharaqi* in a good Nile was avoided.

Instructions for emptying the Basins into the Bahr Yusif.

10. — Major Brown refers to this in the following terms :

> « In spite of the high level of the High Nile, the Minya Basins were not full when Asyût Province discharged its basins; the Chief Engineer states that there remained 120,000 feddans *sharâqi* at this time. The Chief Engineer managed his discharge operations well, and satisfactorily completed all the irrigation and even gave the West of the Yûsifi a longer inundation than the lands there have been accustomed to, so that the crops of the following winter were very good. His difficulties were increased by the management of the Yûsifi Head at Derût, the instructions I left when I went on leave not having been followed. My instructions were.
>
> If Beni Suêf basin are nearly full, close Yûsifi Head at Derût *as soon as West of Yûsifi in Minya is finished.*
>
> If Beni Suêf Basins are empty, Yûsifi must be left open, till Abou Khadigah is about to be cut. From Derût to Qosheshah in flood time is four to five days. Consequently the Yûsifi would ordinarily be commenced to be closed about five days before the cutting of Qosheshah.
>
> This applies to ordinary years, but no rule can be laid down. The time for closing the Yûsifi and Sahiliyah can only be decided on at the time, by taking into consideration the actual state of the basin.

Though Asyût Province did not discharge Dalgawi till the 12th October by cut Sharmûkh, Yûsifi head had been closed on 7th October and been gradually reopened, less the lock, from the 8th to the 11th October; fully closed again on the 12th October, reopened again, less the lock, from the 13th to the 21st October and closed again on the 22nd and Minya being short of water up to the 21st of October.

To make good the want of water, resulting from such an incomprehensible method of handling the Yûsifi, numerous cuts in banks were rendered necessary in Minya Province; and instead of reopening fully the Yûsifi Head with its lock to remedy the evil, when it was recognised, further cuts on to the Yûsifi from the Northern basins of Asyût were ordered. Fortunately the Chief Engineer of Minya (who was in no wise responsible for the mistake made at Derût) was equal to the occasion: otherwise there might have been the reproach of sharâqi existing on a large scale, in the Minya Province in so good a Nile year as 1889 ».

Ismail bey Sirri, the assistant of the Inspection of the 4th Circle, was in charge of the Division at the time of these events, Major Brown being absent on leave ; Sirri bey is responsible for the handling of the Bahr Yusif at Derut. He was anxious to save *Dura* which had been sown at too low a level and therefore reduced the level of the Bahr Yusif without consulting the Chief Engineer of Minya enough. He should have maintained also a more constant communication between the two Mudiriahs of Asyut and Minya.

Emptying Basins Beni-Suef including Qusheshah Basins.

11. — The Beni-Suef Province at the tail of the Middle Egypt chain is well supplied with red water feeders and its basins were full at the time of emptying. The Qusheshah basin was cut on to the Nile on October 28th, at noon with a head of 1.54 metres. The Nile next day was 0.84 metres higher and at Rodah the rise was only 0.36. This shows that in years like 1889 when the Nile is high at the time of emptying the basins, there is no fear of any marked flood in the Delta.

The Gizah Basins.

12. — The Gizah basins were emptied very carefully and slowly in accordance with the wishes of the people. The Abu Nomros

Escape recently repaired, stood a head of 1.5 metre with the Bridge completely open for 15 days. This excessive head with open arches is not to be recommended, as the downstream action is excessive and in many cases might wreck the Bridge.

Improvements in basin works.

13. — From Aswân to Asyut, the Basin system improvements have been projected in conformity with the wishes of the people who are invariably most anxious to have any improvements in the supply of red water. They were always consulted by me when engaged in drawing up the proposed projects which have been detailed at length in the Pamphlet. "*Report on the Low Nile of 1888 and on the measures to be undertaken to prevent Sharâki.*" Their views were always found to be very correct when they were consulted about the general remodelling of a system.

The sum to be spent between Aswân and Asyût is L.E. 505,548 spread over three years. Of this sum, a large portion will fall on the Ordinary Budget of repairs.

In Middle Egypt, on the East, there can be no great improvements.

On the West, great improvements have been effected by Major Brown in supply of water and in regulation of Bridges, and in his opinion the following works are necessary :

1) Red water Nile feeder for Basins Deri Mangatin and Membâl, with a new syphon under the Ibrahimîyah.

2) Regulators on the Bahr Yusif (two at least).

3) Bridges in the Bank of the Bahr Yusif to feed the basins in Low Nile when the Nile feeders are not acting well.

4) A Regulator in the Ibrahimiyah at Qalandûl to enable flood water to be passed in large quantities below Derût and thence into the basins. At present this is not possible, owing to the small section of the Ibrahimiyah Canal below Qalandûl which cannot take more water than at present from the reach above Qalandûl.

In East Gizah, improvements have been shelved owing to the proposal to establish pumping engines at the head of the system opposite Wastah, about 85 kilometres South of Cairo. This project is still under discussion. If Sefi irrigation is introduced, there will be no danger of Sharâqi from a low Nile like 1888.

Sahil Irrigation in West Gizah.

14. — In West Gizah the only thing required is a system of Sahil irrigation. At present the Sahil is chiefly irrigated towards the end of the season by flushes from the clear water of the basins or by lift from the Nile by *shadûfs*.

The Eastern edge of the main chain of basins also gets little red water as the supply canal flows under the Hills on the West. A commencement was made of the improvements required by partially excavating a Sahil canal. But the funds had to be diverted to the more important Upper Egypt works. With these red water carrying Sahil canals the produce of Gizah should be much increased.

CHAPTER II.

Sefi or Summer Irrigation 1889.

State of summer supply 1889.

15. — The summer supply in the Nile was in 1889 one of the lowest on record. The gauge at Aswân has been recorded daily since May 1869. No records exist before this and the Rodah gauge is affected by the manipulation of the Barrage so that no comparison of minimum gauges can be made with former years.

The following table shows the dates of falling below one cubit and rising above one cubit at Aswân for the last 20 years. The number of days during which the Nile sank below one cubit is a very fair test of the summer failures of supply.

Table of minimum gauges Aswân.

YEAR	MINIMUM GAUGE				DATE OF DROP BELOW ONE CUBIT	DATE OF RISE ABOVE ONE CUBIT	N° OF DAYS BELOW ONE CUBIT
	DATE	CUBIT	KIRAT	REDUCED SEA LEVEL			
1870	15 June....	0	15	85.50	20 May....	24 May....	3
1871	16 May....	1	13	84.99	nil	nil	..
1872	24 May....	1	0	84.70	24 May....	26 May....	1
1873	3 June....	0	21	84.63	20 May....	6 June....	16
1874	29 May....	0	8	84.34	11 April...	2 June.. .	51
1875	23 May....	1	21	85.17	nil	nil	..
1876	9 June....	1	19	85.13	nil	nil	..
1877	26 May....	1	18	85.10	nil	nil	..
1878	7 June....	0	6	84.29	22 April...	26 June....	64
1879	23 May....	5	1	86.88	nil	nil	..
1880	3 June....	3.	2	85.82	nil	nil	..
1881	10 June....	1	16	85.03	nil	nil	..
1882	21 June....	0	13	84.45	11 May....	25 June....	44
1883	21 June....	1	15	85.04	nil	nil	..
1884	25 May....	2	6	85.37	nil	nil	..
1885	21 June....	0	18	84.56	25 May....	2 June....	29
1886	3 June....	1	11	84 95	nil	nil	..
1887	5 May....	1	12	84.97	nil	nil	..
1888	5 June....	1	10	84.92	nil	nil	..
1889	4 June...	0	11	84.40	13 April...	27 June....	71

It will be seen from the above that the water remained longer below 1 cubit in 1889 than any year since 1870.

Mean gauges of the Delta and discharges of low Nile at Cairo.

16. — The following are the mean gauges of the summer supply which concern the Delta :

MONTH AND YEAR		SHUBRAH GAUGE	UPSTREAM ROSETTA BARRAGE GAUGE	DOWNSTREAM DAMIETTA BARRAGE GAUGE	DOWNSTREAM RAYYAH MENUFIYAH GAUGE	MANSURAH GAUGE	ASWAN GAUGE Cubits	ASWAN GAUGE Kirats
January..	1887	14.30	13.23	13.25	13.01	2.87	5	18
	1888.	14.50	13.48	13.30	12.90	2.96	6	06
	1889.	13.60	13.00	12 86	12.87	2.65	4	0
February	1887.	13.80	13.10	13.10	11.47	2 76	4	09
	1888.	13.70	13.00	12.70	12.83	2.20	4	10
	1889.	13 32	13.00	12.60	12.88	2.27	2	10
March ...	1887.	13.70	13.22	13.10	12.90	2.60	2	22
	1888.	13.50	13.05	12.50	12.93	1.89	3	02
	1889.	13.20	13.00	11.80	12.84	1.30	1	12
April	1887.	13.10	12.76	12.45	12.14	2.10	1	19
	1888.	13.30	13.01	12.24	12.90	1.54	2	05
	1889.	13.19	13.00	11.40	12.84	0.60	1	0
May	1887.	13 08	12.84	12.10	12.66	1.60	1	19
	1888.	13.28	13.03	11.90	12.86	1.20	1	18
	1889.	13.16	13.00	11.10	12.84	— 0.19	0	14
June.....	1887.	13.16	12.95	12.15	12.74	1.70	2	22
	1888.	13.20	12.96	11.50	12.80	0.78	1	20
	1889.	13.08	12.90	10.80	12.75	— 0.25	0	14
July.....	1887.	13.50	13.26	*	13.05	1.24	7	16
	1888.	13.28	13.05	*	12.88	0.83	4	15
	1889.	13.02	13.08	*	12.90	— 0.38	3	14

* Opened Barrage 2nd July 1887.—Average up to 20th July at Shubrah.
do. do. 31st July 1888.—Average up to 26th July at Shubrah.
do. do. 29th July 1889.—Average up to 9th July at Shubrah.

The following discharges were taken by Mr. Reid on May 16th at the Barrage and those of July 7th were deduced from them.

DATE	ROSETTA BRANCH		DAMIETTA BRANCH		RAYYAH MENUFIYA		TOTAL DISCHARGE M³ PER DIEM
	GAUGE	DISCHARGE	GAUGE	DISCHARGE	GAUGE	DISCHARGE	
May 16 ...	10.00	2,820,864	11.00	6,044,210	12.90	7,987,680	16,852,754
July 7.....	9.60	2,100,000	10.70	5,050,000	12.65	7,200,000	14,350,000

The discharges of July 7 were practically the minimum of the year. If we add 3 millions for the supply of the canals taking off between Cairo and the Barrage we have a minimum of 17,350,000 M³ per diem passing Cairo.

The Shubrah gauge gives the level available for distribution to the South East by the Ismailiyah, Sharkawiyah and Basûsîyah Canals.

The upstream Rosetta Barrage gives the mean of the surface level to which the Barrage was held. The downstream Damietta Barrage gives the amount of water passed down the Damietta Branch for the remainder of the Eastern Delta and the riparian engines on the West Bank of this branch.

That of the Rayyah Menufîyah gives the water entering into the great central Delta Provinces of Menufîyah and Gharbîyah.

That of Mansurah shows the amount below the off takes of all the Canals on the Damietta Branch.

Comparison of out turn in cotton of 1878 and 1887.

17. — If we compare the very low Summer Nile of 1878, which closely resembles the year 1889, we find that the cotton exported from Alexandria :

1878 1,680,595 kantars.

1889 3,200,000 of which perhaps 200,000 kantars were from Upper Egypt.

This magnificent increase has been obtained by utilizing the whole amount of water in the river by holding it up at the Barrage and the "Sadds" (earth and stone dams across the river). The great personal efforts of the Engineering Staff aided by the civil authorities also contributed to this magnificent result. It must be borne in mind also that the yield of 1878 per feddan was greater than that of 1889 owing to the existence of the cotton worm in greatly increased numbers in 1889. The area of 1889 is probably four times that of 1878.

Mit-Afifi cotton.

18. — *Mit-Afifi* cotton is now every year largely on the increase. This is a cotton which stands drought less than the *Bamia* and *Ashmûni* varieties and its being sown shows an increased confidence in the water distribution. Mr. Garstin mentions Dakahliyah as still very conservative in adhering to the cultivation of *Bamia* and *Ashmûni*.

Cotton cultivation in low lands of inferior quality.

19. — The spread of cotton to the low lands of inferior quality has taken place greatly in the last few years. The immediate result has been to lower the average yield. The low lands cotton speedily exhausts the poor soil and thus the people are driven to sow rice to reclaim the exhausted Land. Owing to the great spread of all sorts of Summer cultivation in the Delta, the Canals in a low Summer Nile are barely able to irrigate the cotton and vegetable crops and are wholly incapable of irrigating a large area of Summer rice. In some local places where a comparatively small area of cotton exists, and the land is being reclaimed (mostly by rich proprietors as on the Mahmudiyah canal), rice is very largely irrigated. It requires at least double the amount of water.

Necessity for reclamation by colmatage.

20. — The rice cannot be increased until we have storage reservoirs and thus for the cultivation of these low Northern lands we must have for the present a system of colmatage by the red water of the Nile flood. This gives great results in increased winter crops and constantly renews the productive power for cotton. I consider myself that colmatage by red water is far preferable to improving the land by summer rice as the expense of irrigating this species of rice by engines is almost prohibitory. If we give the summer rice free flow the water is so lavishly used that the requirements mount up to 60 cubic metres per feddans and thus 100,000 feddans of rice in Gharbîyah alone would require 6 millions cubic metres per diem or about $^1/_3$ of the supply available for the entire Delta in a low summer Nile.

Works necessary for colmatage.

21. — Colmatage requires much careful arrangement both for giving the red water in basins with a fair depth and in having proper drainage canals. The colmatage done by local proprietors is not nearly enough and the wished for results can only be had by making basins of 1,000 feddans. This means that Government must interfere and carry on the work.

Mr. Foster on rice cultivation.

22. — Mr. Foster who has had much experience in rice irrigation grown by Europeans and large native proprietors writes the following:

> « No rice was planted in lands irrigated by the Khatatbah canal and branches, and the area of this crop irrigated by the Mahmudîyah was much less than usual. Landowners state that nearly all the rice died except that on the Rosetta and the Mehallet-Khel canals. They complain that five days is too long a stoppage of water for this crop. The rotations on the branches of the Rosetta and Mehallet-Khel canals were of much shorter duration and here the rice was very good. I am of opinion that rice cannot remain more than five days without a change of water without damaging the outturn. If water can be given exactly at five days interval the crop will get on quite well, but it is the danger of failure to supply water in any one period owing to whatever cause either insufficient machinery for lifting on remoteness of the Land from the source of supply, this instigates Land-owners to complain. It is quite certain that much rice did die, but most of it was situated at a distance from the Mahmudîyah and probably was not irrigated regularly. Rice as a crop is a poor one, but it enables Land-owners to reclaim salt land at a lower cost and is therefore valuable, and as every feddan reclaimed is an increase of wealth to the country, the demands of rice cultivation must not be ignored. »

Intensity of demand and pressure in the different Circles.

23. — Of the four Circles of Irrigation, the 4th containing the Ibrahimîyah canal and the Fayûm is the hardest pressed in June. As in a low summer Nile the supply falls to about 52 per cent of the March supply by which the crops are sown.

The 2nd Circle containing the rich and highly cultivated provinces of Menufiyah and Garbiyah has a very small summer supply in proportion to its area cultivated. Here although the June supply was only 14 per cent lower than that of March, the area actually irrigated of other crops than cotton was very great and great pressure existed in June.

In the 3rd Circle, the pumps deliver steady water supplies, and were it not that rice cultivation takes a very large amount of extra water in June and July, there would be no pressure.

In the 1st Circle owing to a large number of wells and many engines on the Nile, the pressure is not felt in June save where a local canal is manifestly unsuited to its work.

In July, the rise of the Nile on the Ibrahimîyah system (including the Fayum) renders the sowing of the *dura* crop easy, but in the Delta, the *dura* (maize) crop is sown at a time when there is no increased supply available. For up to 1889 the Barrage cannot be raised above its normal level of 13.00 and thus in all canals taking from above the Barrage there is no practical increase of supply in a bad year till nearly the end of July, and the *dura* crop is sown by economizing the water available for the cotton and rice.

In future, in a bad summer the gradual raising of the river to 1.400 by maintaining the Barrage shut, will increase the discharge of the canals taking off the Barrage by at least 50 per cent and practically remove all pressure in July when the *dura* is being sown. The quality of the *dura* will be very much improved owing to the early sowing.

Areas of cotton 1889 and three previous years.

24. — The table printed below showing the area of cotton sown in the past three years is from the Finance Ministry's statistics compiled by Mr. Boinet Bey. The yield of cotton in 1889 was all round greater per feddan than in 1888 although here and there the crops suffered from drought. It would be rash to generalize from one year, but it was frequently observed that the crops on engines which were not subjected to rotation and which were therefore watered every 10 days according to custom suffered more from worm than the crops which got water every 20 to 25 days. The increased yield is generally seen by the work done in the ginning factories. Thus in Sharkîyah, the factories worked up more cotton last year while in the Beni Suêf Mills, which work up the Fayûm and Beni Suêf cotton, the work done was much less.

MUDIRIYAHS	AREA OF COTTON PLANTED			
	1886	1888	1888	1889
	Feddans	Feddans	Feddans	Feddans
Asyût	5	144	1,053	1,212
Minya	2,134	1,800	6,422	10,887
Beni-Suef	9,962	16,583	18.738	14,183
Total 4th Circle...	**12,101**	**18,530**	**26,213**	**26,282**
Fayûm	35,088	47,625	70.960	66,126
Total Ibrahimiyah...	**47,189**	**66,155**	**97,173**	**92,408**
Behera (on pumps)	**110,743**	**105,405**	**134,604**	**116,382**
Menufiyah	111,453	106,401	105,251	74,953
Gharbiyah	275,125	263,564	310,248	245,433
Total 2nd Circle...	**386,578**	**369,965**	**415,499**	**320,386**
Kaliubiyah	37,226	37,018	45,388	38,495
Sharkiyah	133,820	131,042	152,725	126,937
Dakahliah	157,727	153,912	173,352	153,201
Total 1st Circle...	**328,773**	**321,967**	**371,465**	**318,633**

Sefi Irrigation 1st Circle. The sadds or dams in the Nile.

25. — *Sefi in 1st Circle.* — In the 1st Circle, (the country East of the Damietta Branch) the scarcity of water was decidedly obviated by the very skilful maintenance of the *sadds* and bars of stone and earth across the Nile. The Damietta Branch was ponded up by the *sadd* at Mit Ghamr to such an extent that the river to the North was so low at Mansourah that children could walk across it. The *sadds* of Benha and Mit Ghamr have held up as follows as maximum heads.

	1888	1889
	—	—
Benha *sadd*	1.50	2.25
Mit Ghamr *sadd* ...	1.43	3.20

These enormous maximum heads were practically maintained for nearly all July, and no accident would have occurred, had it not been for the unfortunate breach in the 2nd Circle in the Rayah Menufiyah which necessitated turning water suddenly down the Damietta Branch. Luckily the breach occurred within four days of the time fixed for removing the *sadds*.

The Damietta *sadd* was fully closed this year but somewhat too late to prevent a rush of salt water for about 50 kilometres. The Cost and details of these *sadds* were as follows :

NAME	STONE	EARTH-WORK	COTTON SACKS	SAND BAGS	COTTON SHUTING	ROPE BAGS		COST
	m³	m³	N°	N°	N°	N°	m³	L.E.
Benha........	8991	1113	50			20	3830	6690
Mit-Ghamr...	7796	17529	2712	4878	2355			6493
Damietta.....	A forfait and dredging...........................							4700

Recoveries of stone.

26. — The stone recovery was :

Benha	8,955 M³
Mit-Ghamr .	8.089 M³
	17,044 M³

This stone is valued at 8,522 L. E., but unfortunately it had all to be thrown into the holes formed by the breach of the *sadds*. The *sadd* contractors Messrs. Murdoch and Templeton deserve great credit for the way they watched the *sadds* and speedily repaired any weak points. Their work in maintaining the *sadds* was very arduous.

27. — Full rotations were put in force as follows : Rotations.

NAME	DATE OF FIRST STOPPING ENGINES	DATE OF FIRST STOPPING CANALS
Kaliubiyah	21st June	26th March
Sharkiyah	6th July	2nd July
Dakahliyah	27th June	1st July

In the latter part of the time of scarcity, very severe rotations had to be put on.

Sefi Irrigation 2nd Circle. Sources of supply present and future.

28. — *Sefi Irrigation 2nd Circle.* — This Circle being the real Delta between the two branches of the Nile receives its water mostly from the Rayyah Menufiyah from above the Barrage. There are however narrow tracts on the edge of the Nile on both branches which are irrigated by engines from the Nile direct and a small area on the extreme end of the Rosetta Branch which derives a small supply of water from above the dam at Mehallet-el-Amir. For 60 kilometres from the sea on the Damietta Branch and 50 kilometres from the sea on the Rosetta Branch, the tract is very narrow and the land falls away immediately from the Nile and is very poor. Mr. Willcocks gives this area irrigated direct as that irrigated by a discharge of 750,000 M^3 per diem on the Damietta Branch and 450,000 M^3 per diem on the Rosetta Branch, and of this, he estimates 600,000 M^3 and 400,000 M^3 per diem as lifted out of the reaches affected by salt water and therefore dependent on the dams at the river mouth. This discharge appears to me to be somewhat exaggerated in its proportions as it only leaves 150,000 for the irrigation of the reach. — Barrage to Mansurah — on the Damietta Branch. The figures are got from multiplying the H. P. by the possible maximum amount raised and is probably not attained to in practice. The amount withdrawn from the Nile reaches affected by salt is certainly large taking both

banks into consideration and must be supplied by the riparian canals, when the dams at the river mouths are no longer made. In the 2nd Circle the riparian canals were partially enlarged in 1889. This caused a serious increase to the maintenance charges.

Water distribution.

29. — The distribution of the water was done by the Inspector personally, aided by his staff and the civil officials.

The system of rotation was put in force in March and continued with constantly increasing severity until the rise of the Nile flood. During July the demand for sowing *dura* or maize began and the canal officials aided by the civil officials were much overworked. It would seem that in these rich provinces, the cultivator irrigates more than in others nearly half of his small plots every year by *sakiyah*, *tabuts*, and Archimedean screws. These are difficult to subject to rotation and the result was that even with the greatest exertions water failed to get down to the tails of some of the canals. A system of 10 days rotations was adopted this year instead of seven, and this was found to give better results as it gave cotton a watering once in 20 days. It also fits into the Coptic months which are those best understood by the Fellahîn.

Periods of watering cotton.

30. — Mr. Willcocks notes as follows :

Where the rotation system did not fail and one irrigation per twenty days was secured, the cotton gave magnificent yields. The yield was better than what it was on the Nile where there was no limit to the Irrigation. Crops irrigated once in thirty days suffered slightly, irrigated once in 40 days suffered appreciably, and irrigated once in sixty days preserved their foliage, but gave no yield. The experience gained in 1888 was very valuably during 1889.

Long Canals such as the Sahel and the Khadrawiyah were divided into reaches of some 35 or 40 kilometres each and fed from new feeders. If this were possible everywhere there would be no necessity to stop engines except on the main *Bahrs*.

The Qàsid with its great length and innumerable branches had 10 days closures of its minor canal heads and stoppage of its engines alternately. This was fairly successful. The minor canals were all deepened and widened to allow of this. The same was done on the Gafariyah and Bahr Shebin minor canals. The Bahr Saidi was fed through the Masraf Om Yusuf. By this means it got every cubic metre sent down to it, as there are no machines in the masraf and 25 difficult kilometres were got over.

The three canals where irrigation failed were the Nenaïah, Sirsawia, and the Bahr Sef. These canals are between 90 and 50 kilometres long each and traverse the heart of the small-holdings, tracts, where sakïyas abound. Stoppage of engines without stoppage of *sakiyas* has been proved to be of no avail; and in 1890 it has been proposed to stop every kind of irrigation as well as the engines. The sheikhs have unanimously given their consent on condition that whenever the engines are stopped for 10 days, the *sakiyahs*, &c., will be stopped for 6 and run for 14 days. If the Mudir can enforce this rotation, irrigation will be easy.

Sefi Irrigation 3rd Circle. Souces of supply.

31. — *3rd Circle Sefi.* — In the 3rd Circle, the water pumped from Khatatbah and Atfah was distributed most carefully by rotation commencing from the 17th of February. In this Circle, the people have, since the necessity of sending applications for *sakïyahs* was abolished, built large numbers of *sakïyahs*, and although this is a gratifying sign of the existence of capital, it has somewhat thrown the canal system out of gear more especially on the Rosetta canal, and the result has been that the small quantity of water available for the Rosetta canal frequently failed to reach Rosetta. Up to the present, native opinion has been very averse to imposing rotations on *sakïyahs*, but as they have multiplied so much, it will be necessary in the future to impose it more especially on canals where there are large towns dependent on the supply reaching the end of the canal.

Dam in Nile near Rosetta.

32. — The Rosetta dam was made this year for L. E. 9,170 of which L. E. 3,144 were paid from the Regular Budget and L. E. 6,026 from the Corvée Relief Budget. The work was done *à forfait* for 9,000 L.E. and 170 L.E. were spent in contingencies. The cost of the dam since 1886 has been.

1886	1887	1888	1889
L.E.	L.E.	L.E.	L.E.
11,384	10,649	10,840	9,170

Mr. Foster has paid great attention to cutting the dam on the rising Nile so as to prevent the scouring of deep holes, and the result is that the *à forfait* price in 1890 is only 8,000 L. E.

Dam at Khatatbah.

33. — The Khatatbah dam principally made of stone is necessary to maintain the river to contract level at the Khatatbah pumps. The head on it is not great and it is always thoroughly in hand. The comparative cost is this :

1885	1886	1887	1888	1889
L.E.	L.E.	L.E.	L.E.	L.E.
1,426	2,608	2,329	818	1,656

Quality of water.

34. — The amount of water passing through the Rosetta Branch in the low Nile of June and July was $1\ ^{1}/_{4}$ million m^3 per diem and the amount drawn out of it by the Khatatbah and Atfeh pumps was $3\ ^{1}/_{2}$ million m^3. Hence the balance or 2,000,000 m^3 was drawn from the filtration water of the river. The filtration water is salter than the Nile and is therefore not so fit for use. The Atfeh pumps so exhausted the supply of fresh water that the Nile at Atfeh (60 kilometres from the Rosetta dam) was a still water pond held above the sea level by the dam and which had a film of fresh water on it only 40 centimetres deep floating on the top of a deep layer of salt water, so salt as to be quite unfit for irrigation and drinking purposes. Had the low supply lasted one week longer, we should have been compelled to deprive the Central Eastern Provinces of a portion of their water to sweeten this great pond from which Alexandria draws its drinking water, as it was falling at the rate of 2 cents a day, and the water wheels of the Atfeh pumps could not have worked with a further fall of 30 centimetres.

Pumping water. Rates.

35. — The Beherah Province is supplied during the greater part of the year by the pumps of Khatatbah and Atfeh. The ordinary payment for the water supplied by these pumps is 42

and 28 L. E. per million cubic metres supplied. Any excess over the contract quantities of 2 ½ millions per diem is paid at Khatatbah at 60 L. E. and at Atfeh over 2 millions per diem at 42 L. E. for the first half million and 60 L.E. for the second.

A fixed payment of L. E. 26,320 in addition to these sums is paid to the Behera Irrigation Company.

Times of working pumps

36. — The Khatatbah pumps worked as follows:

Commenced 8th December 1888,
Stopped 30th April 1889.
Recommenced 17th May 1889,
Stopped finally 4th August owing to rise of Nile.

Total number of days running 224. Average discharge per day 2.02 millions.

The Atfeh pumps:

Commenced 16th October 1888,
Stopped 29th November 1888.
Recommenced 9th December 1888,
Stopped finally 13th August 1889 owing to rise of Nile.
Total number of days running 283.

Owing however to salt water in the river, they were stopped 12 days in this period, and thus the actual number of days run is 271.

Average discharge per day 1.80 million.

Cost of pumping in 1889.

37. — The actual sum paid to the Company for pumping was in addition to the fixed charge of 26,320 L.E., 33,679 L.E. making a total of 59,999 L. E.

Stoppages of pumps on account of salt water.

38. — The stoppages on account of salt in the river were 294 hours altogether of which the whole number were before the Rosetta dam was closed. After the dam was closed the pumps were never stopped even when the sea water was higher than the river.

Quantity of water pumped onth by month.

39. — The following table shows the actual quantity pumped month by month compared with 1888. The season of 1889 begins in October 1888 after the subsidence of the Nile.

MONTH	KHATATBAH MILLIONS		ATFEH MILLIONS	
	1889	1888	1889	1888
October..... 1888............	...	...	37	...
November... »	...	...	57 1/4	3
December... »	44	...	12 1/2	16
January..... 1889............	42	...	15 3/4	16
February ... »	58	30 1/4	27 1/2	29 1/2
March....... »	87	62 1/4	58 1/2	46 3/4
April ...... »	70 1/4	77 3/4	60	48
May .... »	32 1/2	85 1/4	62 1/2	77 3/4
June........ »	52	99 3/4	55 3/4	79
July........ »	57	77 1/2	69	93
August...... »	10 1/4	25 3/4	31	81
September... »	...	...	...	...
Totals.....	**453**	**458 1/2**	**486 3/4**	**490**

Excess of 1889 over 1888 in water pumped.

40. — The excess over 1888 (or over October 1887 to August 1888) is principally due to the very low Nile of 1888. Owing to the lowness of the Nile flood, the Atfeh pumps began running in October and continued all through the winter of 1888/89.

uture abolition of pumps.

41. — It is confidently hoped that the Rayah Beherah will furnish enough water in 1890 to do away with the Khatatbah pumps after May 1st.

CHAPTER III.

Ibrahimîyah Canal and Fayûm.

Area irrigated. Supply in summer and flood Time.

42. — This fine Canal taking out from the Nile near Asyut runs for 268 kilometres along the *sahel* of the Nile irrigating in summer an area of 48,000 feddans sugar and 26,000 feddans cotton. It also supplies water to the Fayum with a summer supply of water varying from two millions to 670,000 cubic metres by the Bahr Yusif. The discharge of the Ibrahimîyah varies from 4 to 2 $^1/_2$ millions usually in summer. The area commanded by the Ibrahimîyah is protected from the basins in the low lands by longitudinal banks called « *Muhet* » and all land west of the Muhêt is basin irrigation save in one or two places where a high patch exists which is cultivated with a little cotton. In addition to supplying summer water to the lands enjoying summer cultivation *sefi*, the Ibrahimîyah supplies red water to the basins by eight heads discharging into the basins. These heads serve as escapes for the excess water in the Ibrahimîyah in the flood. The Ibrahimîyah has no head.

New Works.

43. — The works on the Ibrahimîyah are still in progress. Each year sees some improvement made in the canals distributing the summer supply and in the delivery of the basin supply.

Allied to these works, are the red water canals taking from the Nile passing under the Ibrahimîyah by a syphon. Of these, there are three completed.

The Sultani canal passing near Fashn.
Nina canal passing near Biba.
Salim Pasha canal passing near Beni-Suef.

List of masonry works 1889.

44. — The following were the works carried out in connection with the Ibrahimîyah system in 1889.

1)	3 arch regulating head to Selim Pasha canal............	L.E.	1,300
2)	3 Sefi canal regulators in branches of the Amyah canal...	»	600
3)	3 Sefi canal heads on canals Abu-Shushah, Abu-Isa and Derwish....................................	»	719
4)	2 Bridges Moharraq and Qûsiyah	»	2,920
5)	Pipe head under Railway	»	46
	TOTAL for Ibrahimiyah Red water Feeders...	L.E.	5,585

Repairs in 1889.

45. — The repairs of the Ibrahimîyah canal are as follows omitting fractions of a pound :

Bahr Yusef lock..	L.E.	225
Derut Escape..	»	99
Bridges Asyut section.....................................	»	151
Additions to Abu-Baqarah syphon wing walls............ ..	»	263
Additions of grooves to Bridges under the Railway..........	»	401
Bridges Minya including renewal of Planks................	»	333
Bridges Beni-Suef..	»	88
TOTAL...	L.E.	1,560

The woodwork used in the Ibrahimîyah system cannot be separated from the basin Bridge woodwork.

Discharge in Summer 1889 Asyut head gauges.

46. — The supply of the Ibrahimîyah fell to a most dangerously low point during the summer, and the minimum discharge entering the canal was two millions cubic metres per diem. The following table gives the lowest readings at Asyut for the past seven years. The reduced levels are referred to the bottom of the upstream girder of Ibrahimîyah canal railway bridge = 54.035 above mean sea level.

1883.........	13th June............	44.98
1884.........	1st July	45.40
1885.........	26th June............	44.80
1886.........	9th June............	45.14
1887.........	13th May............	45.26
1888.........	14th June............	44.97
1889	28th June............	44.50

The average lowest level of the Nile at Asyut is 45.00 and the river remained in 1888, 77 days below average, i. e. from 21st April to 7thJuly. The Ibrahimiyah head is cleared to the reduced level of 42.30 metres, and thus there were only 2.20 metres of water in the canal on the day the minimum was reached. The difficulties of the situation were further augmented by the early fall of the river in winter and the late rise in June.

Rotation and outturn of crops.

47. — The rotation system was applied with the utmost strictness and by it, much of the crop was saved. It gave general satisfaction and letters have been received from the Daira Sania and Umdahs thanking Major Brown and his staff for their successful exertions. The result is very gratifying, considering the very slight legal authority the Mudir has to enforce rotations of water. The sugar, cotton and *dura* crops were all saved. The sugar crop has diminished yield by about eight millions kilogrames say 8,000 tons in the Daira Estates as compared with good years.

The Factory Engineers say the cane was not ripe when brought to the mills and a low yield is the result. The *dura* crop irrigated and matured on an absolutely faultless Nile, was splendid. Major Brown has been much impressed with the necessity of sowing cane early. The early sown lands get more water for the preparatory ploughings, as there is abundance in the canals at that time, and if Autumn is cold the cane has a better chance of ripening properly before it is crushed.

The cotton crop.

48. — The cotton crop after growing well was decidedly woody in the early Nile, but threw out good flowers and bolls with much leaf. The plants were often 8 to 10 feet hight, but September dews destroyed the 2nd gathering and the total result was poor. The factories at Beni-Suef had not enough work to do

Daira Factories outturns.

49. — The following figures show the Daira Factories outturns. (The year 1890 giving the outturn of the 1889 cane growth.)

FACTORY	CANE CRUSHED QANTARS			SUGAR N° 1 QANTARS			REMARKS
	1888	1889	1890	1888	1889	1890	
Biba.	1,524,426	1,250,763	1,280,245	105,813	82 280	88,782	The years given are those of the Factory season and are the result of the year before. Thus 1890 sugar was from cane sawn in 1889 &c.
Maghagha...	2,220,973	1,455,750	1,108,354	151,303	104,792	75,388	
Matai	1,870,513	1,144,968	945,471	134,113	79,266	64,670	
Minyah......	2,279,773	1,723,024	1,665,409	156,949	126,280	130,248	
Abu-Qurqâs.	1,053,277	1,217,716	1,194,337	75,265	91,764	84,120	
Rodah.......	1,515,838	1,590,616	1,408,486	110,248	118,921	101,873	
TOTALS....	10,464,800	8,382,837	7,602,302	733,691	603,403	545,081	

Damâres Factory outturn.

50. — The following gives the outturn of the Damâres Factory of the Late Sultan Pasha near Minya.

YEAR	SUGAR CANE REC^{ed} BY FACTORY		SUGAR N° 1		SUGAR N° 2		SUGAR N° 3		TOTAL OF N^{os} 1, 2, 3		MELASSES	
	QANTARS	ROT.	QANTARS	ROT.	QANTARS	ROT.	QANTARS	ROT.	QANTARS	ROT.	QANTARS	ROT.
1884	258,855	42	17,201	25	4,549	50	1,449	..	23,199	75	6,034	21
1885	258,406	88	17,356	49	5,015	30	2,349	..	24,720	79	5,293	75
1886	250,425	..	16,920	50	5,062	50	1,723	23	23,706	50	5,372	86
1887	270,983	06	16,872	75	5,141	25	1,890	..	23,904	..	6,580	27
1888	274,548	66	17,590	50	4,605	75	1,440	..	23,636	25	7,683	..
1889	276,505	11	18,477	..	4,819	50	1,352	25	24,648	75	7,933	71
1890	266,218	22	18,074	..	...	..	...	..	...	..	...	..

The results on this well managed estate are very satisfactory as it was subjected to the same system of water rotation as other estates.

IMPROVEMENTS PAST AND FUTURE.

Works of Improvement.

51. — Major Brown has for the past five years been continuously engaged in improving the works for the distribution of summer water. In 1883 the main regulating Bridges of the Ibrahimîyah canal were fairly complete, but the canals of supply were practically without masonry heads. The precious summer supply was passed down old inundation canals (Nili) and various other ill designed channels and there were practically no regulators in the middle reaches. Irrigation was free flow, but only by means of earthen dams. Since 1884 the following has been spent on the summer supply canals (*Sefi canals*).

	ASYUT	MINYA	BENI-SUEF	TOTAL
	L. E.	L. E.	L. E.	L. E.
1884........	1,154	10,875	6.567	18,596
1885........				
1886........				
1887........				
1888........				
1889........				

Including sanctioned outlay of 1890.

Rectification of Minor channels.

52. — The wide Nili canals have been warped in and many badly aligned channels abandoned. New feeders have been taken out, and it is found most advisable to have new feeders from the main canal at every regulating Bridge in groups of three. Experience of the past years shows that if we enlarge the distributary canal to decrease the number of heads, we have to deal with excessively large and unmanageable volumes in flood time.

Normal amount of silt clearance.

53. — The silt clearance of these channels has not yet settled down to a normal amount owing on the one hand to slight widenings and straightenings increasing the cube of work done, and on

the other hand the warping in causes silt to disappear that would otherwise have been settled in a well designed channel.

Works for supply of red water.

54. — For the red water improvements see under the heading of basin irrigation. Para 13.

Discharge of the Canal. Its variation.

55. — The Ibrahimiyah canal falls more than any other canal in Egypt between March and July. This ratio of the lowest discharge to the discharge of the 2nd of March is as $\frac{2,122,182}{4.220.196}$ or 50.3 per cent. This is very much greater than the decrease in the Delta. Were it not that the Nile rises rapidly and thus as the Nile *dura* is being sown, the water is daily increasing the strain would be too great. It differs much from the Delta which is kept without increase of water until the flood rises sufficiently to fill both Branches of the Nile.

Table of Discharges.

56. — The following table shows the fortnightly discharges taken at Derût from March to July :

Fortnightly Discharges at Derût on the Ibrahimîyah canal. March to July 1889.

(CUBIC METRES PER DIEM)

	2rd March	16th March	31st March	16th April	26th April	9th May	25th May	5th June	20th June	15th July
Yusifi..................	2,012,124	1,381,847	1,246,320	1,064,544	1,054,080	970,842	670,343	607,910	588,759	941,855
Ibrahimiyah below Derût	1,602,478	3,384,640	2,059,776	1,804,619	1,787,830	1,641,928	1,601,596	1,546,957	1,222,270	2,585,088
Derutiyah..............	344,321	258,508	292,253	194,641	263,969	246,412	307,307	224,985	263,450	527,399
Sahiliyah..............	261,273	132,536	112,006	119,508	73,681	73,560	73,008	61,897	47,713	173,826
Totals.....	**4,220,196**	**4,157,531**	**3,710,355**	**3,183,312**	**3,179,560**	**2,931,740**	**2.652,254**	**2,441,749**	**2,122,192**	**4,228.178**
Asyut Nile Gauge.......	45.45	45.29	45.14	45.00	44.91	44.79	44.69	44.63	44.55	45.34
Gauge above Derût.. ...	44.00	43.61	43.47	43.31	43.24	43.21	43.16	43.11	43.06	43.54

The distance from Asyût at the head of the Ibrahimiyah canal is 62 kilometres.

It was found necessary, taking into consideration the great area of sugar cane on the Ibrahimiyah canal, to reduce the supply of the Bahr Yusif at Derut and give $^1/_4$ of the visible supply to the Bahr Yusif for the Fayûm instead of $^1/_3$ as heretofore. This was done by order of the Ministry at Cairo on the 15th of May.

DREDGING THE IBRAHIMIYAH CANAL.

Dredging.

57. — The returns for dredging show a very great increase on last years figures. It was resolved to continue the dredging for a longer period than usual to go over again some silt lumps that had been deposited. But Major Brown considers that some of the excess is due to the displacement of the sand in the bed of the canal by the dredgers hulls. The sand floats out behind the dredgers passing the buckets and is deposited a hundred metres or so lower down. In a deeper canal, the action of the hull is much less and therefore we may naturally conclude that the shallowness of the canal owing to the low Nile was the cause of some of the excess. Measures are being taken in the renewal of the contract for 1891 to alter the measurement rules, so that the measurement instead of as at present, being made within twenty-four hours of the passage of the dredgers, shall be delayed till fifteen days. This will be similar to the rules in the other dredging contracts.

SPURS.

Spurs. Their number and cost.

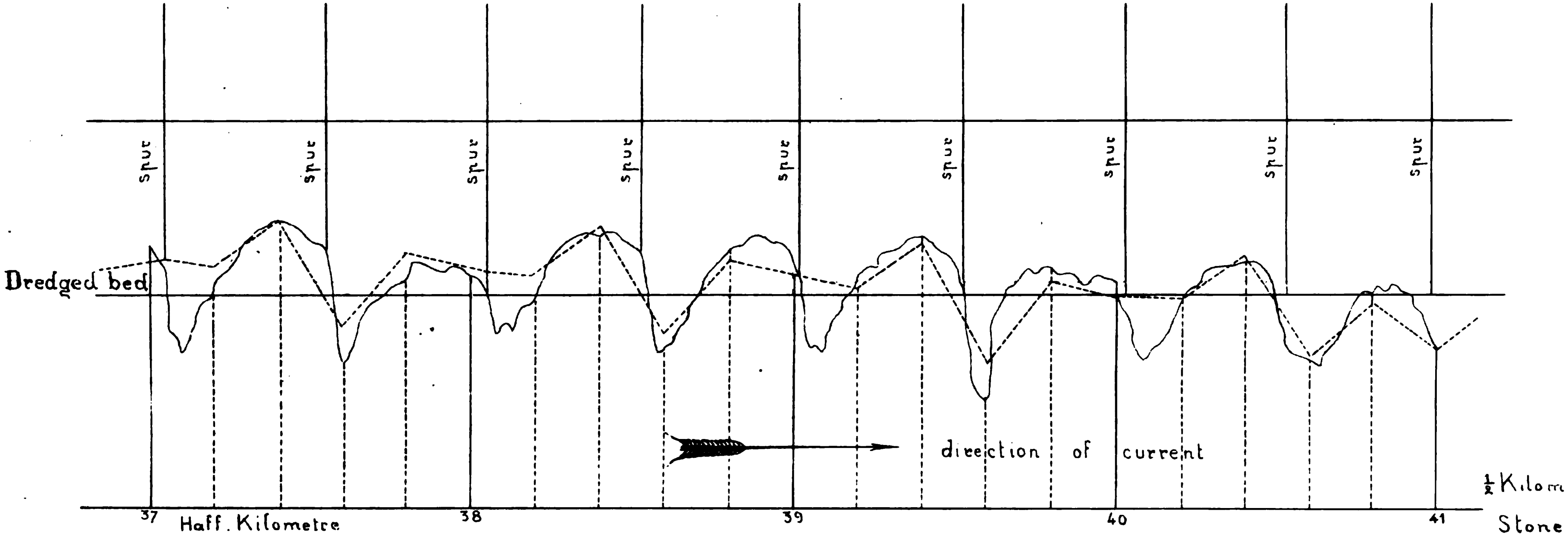
58. — The spurs made for the double purpose of protecting the Railway and of reducing silt deposit have been increased by 31 pairs at a cost of L.E. 1,335, and the 49 pairs previously made have cost L.E. 205 to repair. Each pair costs about 150 L. E. There are now 80 pairs.

These spurs are made at the rate of four to the kilometre. The general result is a deepening of the bed below the spurs and a decided protection of the berm on which the Railway Bank is raised, but the silt is thrown in excess on to the parts unprotected. The spurs at every 250 metres are not enough to keep the silt from depositing. It will be seen on the section opposite that the excavating effect of the spur extends to less than half the distance between the spurs.

LONGITUDINAL SECTION OF THE IBRAHIMIYAH . CANAL

FROM Kilom. 18½ TO 20½

SHOWING THE SCOURING EFFECT OF THE SPURS



Scale { Horizontal $\frac{1}{10.000}$
{ Vertical $\frac{1}{100}$

The full line shows the profile of the bed from soundings at every ten metres made on May 8th 1890; the dotted line shows the soundings of the 15th April at every 100 Mes

The metre depth of sand in the high parts does not of course retard the flow in proportion to its height, as the section of the canal is much wider at the silted parts, but when the canal sinks half a metre the retardation must be much increased.

Quantity of silt dredged.

59. — The following table gives the cubes of dredging for the past years in cubic metres:

YEAR	ASYUT TO DERUT	BELOW DERUT	TOTAL	COST
	Cubic Metres	Cubic Metres	Cubic Metres	L. E.
1884	818,430	330,268	1,147,690	34,656
1885	605,598	182,314	786,912	35,062
1886	461,363	—	461,363	24,429
1887	523,410	—	523,410	23,629
1888	447,088	—	447,088	16,595
1889	629,022	—	629,022	23,071

THE FAYUM.

The Fayum Failure of supply.

60. — The Fayûm was badly supplied with water, the springs in the Bahr Yusif having partially failed from the drought of 1888. The available supply from the Ibrahimiyah was diminished to $^1/_4$ of the discharge at Derut in order to save the more valuable crops of sugar cane on the Ibrahimiyah canal. The annexed table shows that between 30th May and probably 17th July, the supply fell below one million.

Area cultivated in summer.

61. — The area of the cultivation in the Fayûm in summer may be taken at 60,000 to 70,000 feddans out of a total cultivated area of 228,444. This summer area is liable to be exaggerated as the distribution of water in the numerous small canals is made in

proportion to the declared area on it. This is done by the people themselves and it is every one's interest to exaggerate.

Normal supply. Rotations. Conduct of officials.

62. — The supply in a normal year should be, taking 20 cubic metres of water to the feddan, about 1,200,000 to 1,400,000. If the Nile rises early, the period of distress is limited to about twenty days in time, and thus in ordinary years the crop is easily watered without rotations. In 1889 it was found necessary to impose rotations, but Mr. Hewat, the irrigation officer in charge of the Fayûm, and the Mudir were not in harmony and did not work together and thus there was no support given to Mr. Hewat by the civil officials. The people also are exceptionally indisciplined and unaccustomed to control. The result was a loss of cotton, the outturn being very much below 1888 (as shown in the mill ginning factory returns of Beni-Suêf). This Province will in the future be attached to the 4th Circle so that the responsibility of division of supply may rest on the Inspector of the 4th Circle.

Insufficiency of supply of reclaimed lands.

63. — This diminution of supply in the Fayûm will seriously affect the measures of reclamation and conversion of the Hod el-Tuyur into Sefi as if it is found that the increased cultivation on the Ibrahimiyah canal uses up the water so much that the old discharges of the Fayûm cannot be maintained, we must return to the basin system in the Hod el-Tuyur and the Lake Kurun will again rise. Experience will be gained in the next two years as to the amount of supply from the springs of the Bahr Yusif which failed so markedly in 1889. The people will have to take to economising water by lifting it by machines It is certain that for the next five years nothing can be done to seriously increase the available supply entering the Ibrahimiyah at Asyut and thus the Fayûm will always be liable to excessive diminution of supply in the month of June.

Discharges.

64. — The following table shows the discharges entering the Fayûm compared with those entering the Bahr Yusif at Derût.

The difference shows the approximate amount of filtration in the Bahr Yusif.

Fayûm Discharges.

YUSIFI DISCHARGE BELOW DERUT		DISCHARGE PASSING LAHUN ABOUT A WEEK LATER		DIFFERENCE DUE TO SPRINGS ALONG YUSIFI	REMARKS
DATE	DISCHARGE	DATE	DISCHARGE		
		2nd March	2,967,235		
2nd March.	1,602,478	10th March	2,566,557	964,079	Due to a channel emptying itself during a fall.
2nd March.	1,602,478	17th March	2,154,643	552,165	
16th March.	1,381,817	24th March	1,942,768	560,921	
25th March.	1,236,256	31st March	1,825,200	588,944	
31st March.	1,246,320	7th April.	1,746,232	499,912	For six days before 31st March at same level below Derût.
6th April .	1,159,297	13th April.	1,702,391	543,094	
16th April..	1,061,544	21st April.	1,702,391	637,857	Period of slight variation in discharges giving mean increase of 654,180.
25th April..	1,054,080	27th April.	1,719,532	665,452	
25th April..	1,054,080	5th May..	1,713,312	659,232	
		11th May..	1,708,992		
9th May...	970,842	18th May..	1,376,917	4 6,075	
20th May...	751,196	25th May..	1,285,114	533,918	
25th May...	670,343	2nd June.	1,167,281	496,938	
30th May...	608,878	9th June..	1,006,383	397,505	
5th June...	607,910	15th June..	912,239	304,329	
16th June...	588,759	23rd June..	908,928	320.169	
20th June...	588,759	30th June..	791,064	202.306	
25th June...	544,978	1st to 4th July	About 900,000	About 350,000	
		9th July..	500,580		
		13th July..	856,193		
15th July...	941,855	21st July..	1,240,704		

Minimum gauges Derut

65. — The discharge of 500,580 M³ on 9th July appears to be erroneous as the Derût gauge varied very little between 20th June and 10th July.

The minimum gauge in the Bahr Yusif was reached on June 28th. After that the discharge rose daily. The gauge readings Bahr Yusif from June 20th to July 10th are as follows at Derût.

DATE	GAUGE	DATE	GAUGE
20 June	41.73	1 July	41.68
21 »	41.72	2 »	41.69
22 »	41.70	3 »	41.69
23 »	41.71	4 »	41.69
24 »	41.71	5 »	41.71
25 »	41.70	6 »	41.72
26 »	41.69	7 »	41.79
27 »	41.68	8 »	41.81
28 »	41.67	9 »	41.81
29 »	41.67	10 »	41.86
30 »	41.68		

CHAPTER IV.

Rayah Beherah.

Progress of Dredging.

66. — The Rayah furnished a small quantity of water during the summer of 1889, the bed having been dredged to 12.00 reduced level at the end of May. The large amount of silt remaining below 13.00 R. L. rendered it necessary to carry on the dredging during the Nile. Accordingly the Dredging Company started their dredgers

during the summer and carried on the work all through the Nile, and by December 31st 1889 had done 642,000 cubic metres. In the year under review they dredged 1,233,000. The Finances advanced 20,000 L.E. out of the 1890 Corvée money, and this enabled work to go on so well that by April 1st 1890, the Rayah was deep enough to float dredgers of the largest size, and with the Barrage at 13.00 the discharge was 2,800,000 cubic metres per diem. By August 1890, it is hoped that the bed will be uniformly deepened to 10.60 at $\frac{1}{20.000}$

Difficulties in Maintenance.

67. — Mr. Foster has conducted the very tedious task of improving this very sandy canal with great patience. The difficulties to be overcome were very great and it was generally believed by all the former Engineers and Administration that the improvement of the Rayah was hopeless. The sand-drifts from 25 kilometres ot desert, the loose sand on the slopes which was carried into the bed by even a very gentle current, the impossibility of using the Corvée or contract labor in such large numbers as the clearance required; all these combined with the failure of the Barrage and its practical abandonment caused the predecessors of the English Engineers to erect the Khatatbah pumps to deliver water from the Nile at the 41st kilometre of the Rayah. Matters were made infinitely worse in 1885 by carrying out the experiment of running full supply in the Nile time without spurs. The result was that the sand came in from the slopes on to the bed destroying the section of the canal completely. For many kilometres, the canal was a flat sandy trench 50 to 70 metres wide and filled with sand to 3 and 4 metres above bed. The clearances effected in this wide section were speedily filled in by the current even of a small summer discharge.

Remedial Measures.

68. — Mr. Foster commenced by making spurs at every hundred etres and planted grass reeds and willows on the banquette starting om the water edge. The spurs were made of burnt brick, sand ones ving failed in 1886 and served to keep the current straight and

to collect much deposit on flat banquettes. The principal factor in the maintenance of a deep channel in the sand is the growth of reeds and grass and willows near the water. Their roots bind the sand very successfully.

Sand screens were also made along the desert edge on the Western bank and by this means Mr. Foster estimates that upwards of 300,000 cubic metres of sand have been prevented from being blown into the canal. These sand screens, though made of very slight reeds bound together, stop the sand effectually, and it is found that when sand gets to a certain height above the level it stops rising.

The Western Desert.

69. — The desert to the West of the Rayah was not a desert originally, as black clay is found in most places from 2 to 3 metres below the sand and living trees are growing in it. It is probable that the digging of the Rayah Beherah by Muhammad Ali or his successor stopped the chain of basin irrigation following the Nile side down to Lake Mareotis. It is found that the black clay underlies the sand nearly all the way down to Lake Mareotis. In some places, tracts 4 to 5 kilometres wide, have been covered.

Restoration of Desert Basins.

70. — Efforts are now being made (though late) to restore the basin chain for 30 kilometres by running two cross banks across the desert at kilometre 19 and 31 of the Rayah. Thus making basins for the reception of the red water of the Nile from the Gizah system. These banks were finished in 1887 and worked with sand bag dams during the Nile of 1887 and 1889. In 1888 owing to scarcity of water the desert basins were not filled. The dams gave a great deal of trouble and cost a great deal of money. Mr. Foster has submitted a complete project for two basin Bridge regulators and for enlarging the Railway culvert to admit of water being passed freely through the system of desert basins to the Khatatbah Canal or back into the Nile if the white water of the basins is prejudicial to the Khatatbah supply. The growth of grass

in the desert after the Nile of 1889 is very remarkable, and when the Gizah system of basin irrigation is improved by the measures proposed in 1888, the desert will in many places be cultivated.

Future Procedure.

71. — In 1890, the Rayah will again be shut in the Nile time and the dredging will be carried on to 10.00 reduced level with 0.06 slope per kilometre. The spurs of the Rayâh Beherah being made on the wide silted bed level will necessarily sink when the bed is excavated to full depth and a further expense will have to be incurred in raising them.

Ultimate result.

72. — The ultimate result of all the great expenditure on the Rayâh Beherah will be that an annual saving of about 30,000 L.E. will be effected in pumping and 9,000 L. E. on the dam at the mouth of the Nile. Unfortunately a great error was made by the engineers of 1881-82 in placing the Khatatbah pumps at Khatabah. If they had been placed at Kafr Bulin, 40 kilometres lower down, they could have given water independently of the Rayâh water coming from above the Barrage and thus the Atfeh pumps and the sea dam could have been suppressed whenever the Rayâh gave 2 $^1/_2$ millions. It is now owing to sandhills practically impossible to run a second canal parallel to the Khatatbah canal to carry pumped water to the great distribution point at Kafr Bulin and when the Rayâh gives 4 $^1/_2$ millions, the Khatatbah pumps are practically drowned out.

CHAPTER V.

Silt in the Upper Egypt Canals.

Diminution of silt in 1889.

73. — It was a matter of much interest to determine whether the enormous deposits of silt that have come every year into the Egyptian Canals was the result of low velocity arising from the low slope of $\frac{1}{25,000}$ or from bad alignment, bad clearance by the Corvée, and injudicious regulation. A great deal depends on this in the future as regards maintenance expenditure, as we must have the low slope to gain on the country in low Nile. The Nile of 1889 being a good silt bearing Nile was a good test. The following canals were carefully cleared and their existing silt banks bear witness to the enormous amounts taken out annually before 1888. The depths of silt are shown on the centre line at 200 metres from the head and at every kilometre.

YEARS	NAME OF CANALS	BED WIDTH	200 M. DEPTH	1 KILOM. DEPTH	2 KILOM. DEPTH	3 KILOM. DEPTH	4 KILOM. DEPTH	5 KILOM. DEPTH	6 KILOM. DEPTH	7 KILOM. DEPTH
1889..	Bayyâdiyah.....	14	0.75	0.90	0.66	0.78	0.42	0.57	0.62	0.72
1890..			0.15	0.24	-0 25	0.10	0.44	0.19	nil	nil
1889..	Shanhûriah.....	..	0.37	0.44	0.26	0.38	0.71	0.65	0.56	0.73
1890..			0.43	0.35	0.13	0.00	0.11	0.14	nil	nil
1889..	Zarzûriyah......	..	1.44	1.07	0.36	-0.20	0.35	0.67	nil	nil
1890..			0.68	0.19	0.30	0.11	-0.33	-0.13		
1889..	Hawîs..........	..	0 72	0.52	0 52	0.49	0.57	0 51	0.21	0.22
1890..			0.07	0.05	0.04	0 01	nil	nil		

N.B. The year 1889 silt is that left by the Nile of 1888, and 1890 silt is that left by the Nile of 1889. The great diminution of silt shown by these figures is very gratifying and we will be able to spend the money usually devoted to these clearances in the enlarging of the canals.

Silt in the deepened and widened canals

74. — Most of the canals of Upper Egypt were widened or deepened in the winter of 1889 save the four above mentioned. In those which were widened and deepened, it is very encouraging to find that the silt in the future will not be great. The following canals show the results of the year. Those marked with an asterisk are still defective in alignment and require some modification.

NAME OF CANAL	BED WIDTH	BED AT CUBITS ASWAN	DEPTH OF SILT AT THE FOLLOWING DISTANCES AFTER NILE OF 1889										
			200 M.	1 Kil.	2 Kil.	3 Kil.	4 Kil.	5 Kil.	6 Kil.	7 Kil.	8 Kil.	9 Kil.	10 Kil.
Asfun * ...	8	9	0.65	0.79	0.40	0.41	0.19	0.01	0.21	0.15	0.14	0.28	0.38
Fàdilîyah *	11	9	0.87	1.16	1.11	0.78	0.26	0.21	..	..	..	..	..
Rannàn....	15	9	0.57	0.36	0.14	0.39	nil	..	..	..	..	..	..
Killàbîyah *	7	10	0.98	0.75	0.65	0.44	0.23	0.21	0.36	0.40	0.18	0.18	nil
Girgawiyah * .	18	9	0.75	0.47	0.32	0.48	0.42	0.35	0.32	0.31	0.39	0.61	0.32
Maàllah.. .	8	10	0.59	0.48	0.46	0.38	0.32	0.15	0.11	0.31	0.25	0.82	0.42
Maànnah...	10	9	0.70	0.15	nil	..	..	..	..	..	..	..	..
Ghilàsi.....	12	9	0.13	0.38	nil	..	..	..	..	..	..	..	..
Damrànîyah	10	10	0.94	0.61	0.44	0.19	0.80	nil	..	..	..	..	..
Tahta......	15	8	0.37	0.61	0.15	0.06	-0.03	0.09	0.19	..	..	..	..
Lahàiwah..	9	10	1.26	0.90	0.51	0.23	0.24	0.15	0.37	0.20	nil	..	..

Of these canals, the Maàllah was not properly cleaned in winter 1889 beyond 8th kilometre.

The Asfun and Killàbiyah are not yet in good order beyond the 10th kilometre.

The Girgawiyah has several masonry works too high.

The Maànnah, Ghilàsi, and Damrànîyah are canals which run directly into the basins and therefore their surface slope is greater than the other canals which are Sàhil canals. The small deposit is very marked. The greater deposit in the first kilometre of the canals on 10 cubits and whose water is shallow is to be observed.

Result of diminution of silt.

75. — In addition to economy of maintenance produced by this careful grading, the absence of silt at the head is of the greatest importance in bad Niles and those Niles which rise early and wane before the time fixed for emptying the basins. For the canal that has not silt on its head continues to give good supplies to the very last.

Middle-Egypt canals.

76. — The Middle Egypt canals from the Nile, passing under the Ibrahimiyah canal, are all of them canals running straight into basins and thus they are very economical.

Causes of silt deposit Upper Egypt Canals.

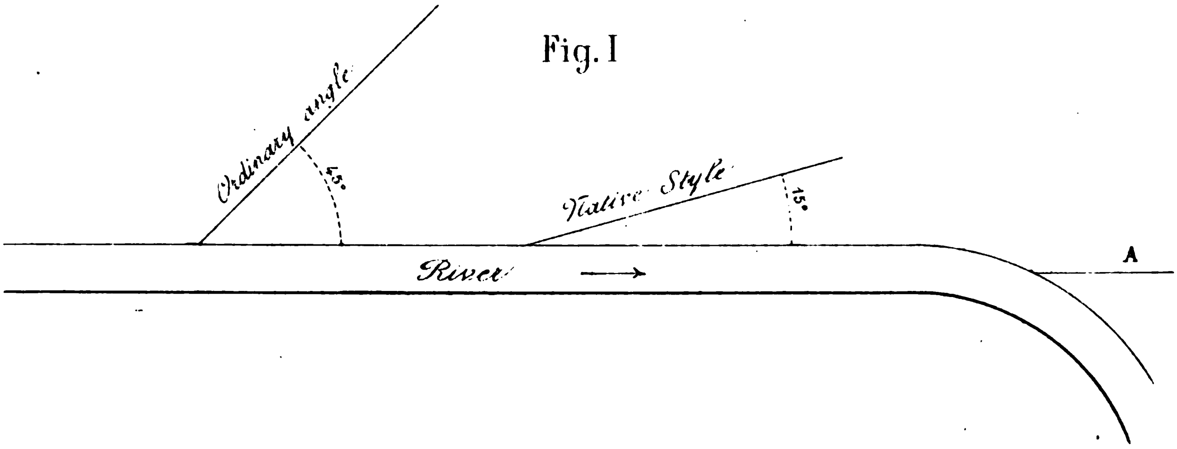
77. — The principal cause of silt in the slow flowing Upper-Egypt canals, is irregularity of alignment. This is caused primarily by their curves being badly executed, and the reaches which are on the whole generally very straight are really composed of a series of short rapid bends. These short bends are much increased by the habits of the cultivators who dig wells in the bed of the canals to water their winter and summer crops and who throw the spoil out into the canal. It is quite impossible to prevent this as the wells are often dug after the Corvée or contractors have finished the clearances. An attempt is made in July to throw back this spoil, but I find a lump opposite each well the next winter and it is quite certain that a flexure is given to the water and a current action is set up which impinges alternately on the right and left bank and which therefore causes silt deposits. The new canal Act will give power to the engineers, and although an excessive use of it is to be depreciated, it will be possible to so fine the offenders that the spoil of the well will be brought to bank.

Irregularity of flow and section of canals.

78. — Another interesting point in the silting of canals has had much light thrown on it this winter and last. I found the native

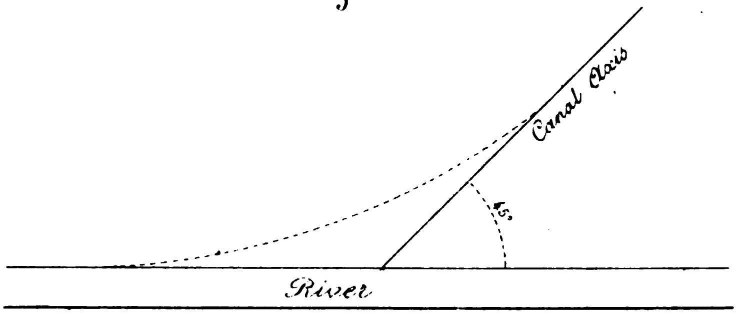
engineers in Upper Egypt always condemned the European practice of taking a canal off at about 45°. The ordinary angle is (see fig. I).

Fig. I



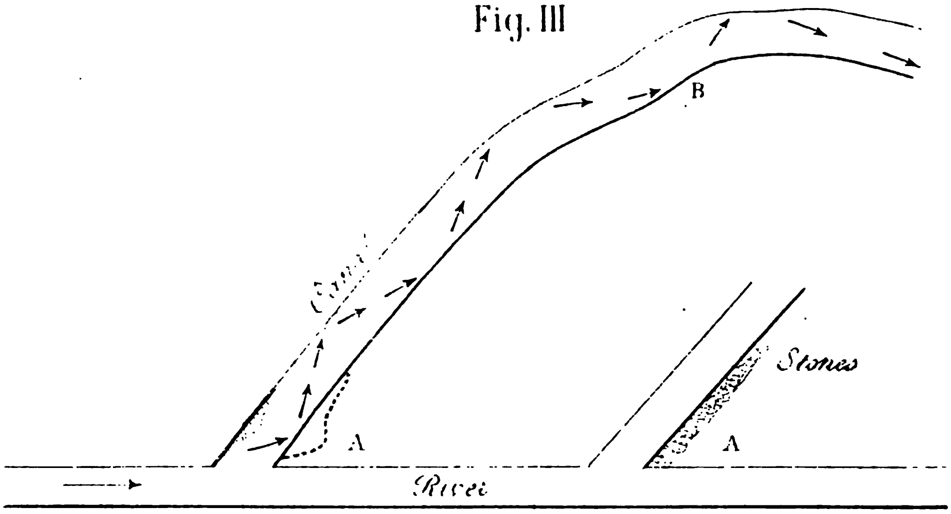
and in cases where they were compelled to take canal off from the Nile at 45° I always find the original canal abandoned and the alignment thus (see fig. II).

Fig. II



This occurs several times in Upper Egypt. I think I have succeeded in observing the reasons why the Arab engineers adhered to their very uneconomical style of canal head (see fig. III).

Fig. III



The set of the river is so strong on A that a recessed cavity is formed and the right and left impinging current action is increased. The original oscillation is much prevented by revetting A with stones so as to make the bank at A unmovable.

This oscillating action is much increased by imperfections in the great curve B which much increases the oscillation till we find that the straight beyond B is, although really a straight run, broken up into a number of contrary flexures which again cause silting in the straight, so much was this in the Fâdliyah canal that, although the end of the curve B is at the second kilometre, the silt dropped till the end of the third kilometre and the sections of the canal were alternately. (See fig. IV).

Fig. IV

These irregular sections do not occur at every 200 metres and therefore as the canals are levelled on pegs placed regularly at every 200 metres, I have been unable to give figures in proof of the observation. The irregularity of the profile is visible to the eye.

Silt caused by absence of retaining banks.

79. — Another cause of silt in the Upper Egypt canals is the absence of banks where the water spreads out into the basins. In some canals, for example the Maannah, the level of mean Nile 10th kilometre is 0.70 above soil and therefore when the Nile is 0.50 higher than mean Nile and the canal is flowing free into the basin, the surface slope is enormously increased in the 5 or 6 kilometres above the 10th kilometre of the Maannah as the water spreads out in a thin film 0.30 to 0.25 metres deep over the basin. The greatly increased velocity of kilos 5-10 is suddenly checked in a still pond and the canal in the 11th and 12th kilometres has every year 0.70 to 0.90 silt on the bed. The Arab engineers knew this and left the canal practically undug. But the result of this was that in low Nile one metre below mean Nile, the canal would not flow at all the water being dammed back on the head. Silt dropped at the head and the canal became a still water trench without discharging power. The remedy for this is either to raise banks in the low basins allowing the water to escape by small distributary canals or to bring the canal itself on to the high *sâhil* lands by deflecting its course and then feeding the low basin from the high level *sâhil* canal.

Deductions made.

80. — I deduce from this that in the interests of economical maintenance, too much attention cannot be paid to the perfection of the alignment of these canals. This is entirely opposed to previous practice Abu Saud Bey in Kena and Mr. Joseph in Girga have made some important rectification of alignments in the winter of 1890.

CHAPTER VI.

Nile Gauges Upper-Egypt.

ites of gauges.

81. — Increased attention was paid last years to the gauging of the Nile in Upper-Egypt so as to get a certain knowledge of the rise at all states of the flood.

Between Aswân and Asyut, the following gauges were kept; those marked with a * being intended to be permanent.

DISTANCE FROM KASR EL NIL KILOM.	NAME OF GAUGE	DISTANCE FROM KASR EL NIL KILOM.	NAME OF GAUGE
945 *	Aswàn.	653 *	Ghelàsi Canal.
861 $^{1}/_{2}$	Ramàdi Canal.	651	Samata Canal.
822 $^{1}/_{2}$ *	Kelh Escape.	635 $^{1}/_{2}$	Rannan Canal.
795	Kellabîyah Canal.	613 *	Tàrif Canal.
784 *	Isna.	599 *	Naga Hamàdi.
778 *	Asfun Canal.	563 *	Abu Shushah.
765	Maallah Canal.	555 $^{1}/_{2}$	Baliana.
755 $^{1}/_{2}$	Mahàmîd Canal.	538 *	Girga.
745	Armant.	520 *	Menshîyah.
735	Bayyàdîyah Canal.	505 *	Akhmîm.
730	Fàdilîyah Canal.	498 *	Suhàg.
704 $^{1}/_{2}$ *	Shanhurîyah Canal.	454 *	Khezndarîayh Canal.
662 *	Tukh Canal.	405 *	Maannah Canal.
663 $^{1}/_{2}$ *	Masraf Gebelaw.	395 *	Asyut Gauge Ibrahîmîyah Canal.

The greatest care has been taken to have each of the gauges referred to a fixed bench mark in the immediate vicinity so that if the gauge is displaced by a boat or by a step of the bank it can be replaced at the same level as before.

Object of the Gauges.

82. — The object of these numerous gauges are:

1) To fix exactly the height of the canal beds so that with 14 $^{16}/_{24}$ cubits at Aswân there shall be three metres of water on the

bed of a canal at its head. This level is called the 9th cubit level at a canal head. (The 9th cubit of Aswân is really 3,06 metres below 14 $^{16}/_{24}$ cubits).

2) To find out in any year the variation of any given state of the Nile flood from the 14 $^{16}/_{24}$ cubit level. This is done by watching the flushes of the Nile. When the rise for any week is finished and the river begins to fall again it is found that the highest point of flood is shown on all the gauges in succession with the utmost regularity in the rising Nile and similarly the ebb or lowest point is shown with equal accuracy. It often happens that a flush or ebb is continued for two days, i. e. the highest or lowest gauges read the same and this also is easily seen on the gauges.

3) To find out the behaviour of the Nile in September when the basins are more or less full.

4) To find out behaviour of the Nile when the basins are being emptied.

Record of the Rising Nile. Its Flushes and Ebbs.

83. — The behaviour of the rising Nile is by far the most important to record. On it depends the entrance of the best water into the basins. The early Nile generally has at least one flush and one ebb of a marked type before August 10th, the general time of basin opening. In the years of very early floods, the flushes and ebbs are of course correspondingly early. The following shows the most clearly defined August flushes and ebbs for the past six years in cubits and kirats at Aswân.

1884 August 11th 13.22 Flush;
— » 20th 13.02 Ebb;
— September 1st 15.21 Flush.
1885 August 16th 14.23 Ebb;
— » 28th 16.11 Flush.
1886 » 16th 15.14 Flush;
— » 20th 15.00 Ebb;
— » 29th 30 15.00 Flush.

1887 August 20th 17.89 Flush;
— » 24th 17.00.
1888 » 13th and 14th 13.08 Flush;
— » 17th and 18th 12.17 Ebb;
— » 24th 14.16 Flush.
1889 » 9th 13.15 Flush;
— » 11th 13.09 Ebb;
— » 19th and 20th 15.08 Flush;
— September 1st and 2nd 17.01 Flush.

It is only in very regular and weak Niles that the flushes and ebbs are not overtaken by a strong succeeding flush, but as the great object of the study of flushes is to know the behaviour of the Rising Nile in bad or average years on the gauges below 15 cubits, the behaviour of the Nile above 16 cubits is of not so much consequence to the supply of the canals as they have a superabundant supply.

Results of analysis of Nile records. Rising Nile at about 15 cubits.

84. — *The analysis of the Nile of 1889 gives the following results*: — 1st If we compare the 14 $\frac{16}{24}$ Flush of August 24th of 1888 and 15 $\frac{8}{24}$ Flush of August 19-20 1889 previous to which period the Basin Canals had all been open, we find the following results:

	DIFFERENCE		DIFFERENCE		DIFFERENCE
Aswân	0.36	Abu Shushah	0.18	Minya	0.30
Armant	0.40	Suhag	0.24	Wasta	0.28
Gebelau	0.34	Asyut	0.19	Roda (Cairo)	0.28

This shows that 15 cubits rise at Asyut is about 18 centimetres less in 1889 than it did in 1888, the Nile being so much diminished by the drawing off of the large discharges of the deepened Canals.

2nd The high flood of 17 $\frac{1}{24}$ on 1st and 2nd September at Aswân came at a time when the basins were not filled owing to the late rise of the Nile. This gives a unique opportunity of studying the course of a 17 $\frac{1}{24}$ pic Nile when its water is freely passing into the basins all along the line.

High flood at above 17 cubits.

85. — In 1887 the Nile reached 17 $\frac{1}{24}$ cubits on August 25th at Aswân and again fell below it on September 22nd and reached its maximum on September 1st 17 $\frac{21}{24}$ cubits. Nearly all the Upper Egypt basins were full by September 1st and this continuous high flood passed by the Canal mouths, the basins themselves breaching into the Nile. The result was that although the highest flush of the flood was on September 1st the maximum gauge (see note on the Nile Flood of 1887) was reached at Sohag 10th September: Asyut 17-18 September: Minya 20-22 September: and Roda Cairo 25th September. The following table is very interesting showing the difference between the passage of the 1889 17 $\frac{1}{24}$ Flood and the maximum rise of 1887. It should be noted that the difference between 17 $\frac{1}{24}$ and 17 $\frac{21}{24}$ at Aswân is 20 kirats or 45 centimetres.

DISTANCE FROM KASR-EL-NIL (CAIRO)	NAME OF GAUGE	MAXIMUM GAUGE OF 1887		GAUGE CORRESPONDING TO 17 $^1/_{24}$ CUBIT OF 1889		DIFFERENCE 1887 OVER 1889	REMARKS
		cubits	kirats	pics	kirats	metres	
945	Aswân	17	21	17	1	0.45	
		metres	cents	metres	cents		
882 ½	Kilh	84	65	84	09	9.56	
745	Armant	78	99	78	57	0.48	
663 ½	Gebelaw	73	81	73	24	0.57	
635 ½	Rannân......	71	76	71	15	0.61	
599	Naga Hamadi.	69	74	68	47	1.27	
563	Abu Shushah.	66	70	65	99	0.71	Probable error in 1887.
498	Suhâg........	62	22	61	00	1.22	
395	Asyut........	52	86	51	86	1.00	
245	Minya........	39	96	39	08	0.88	
88	Wastah......	26	74	25	68	1.06	
4	Cairo (Rodah).	20	63	19	05	1.57	

A cubit at Aswân is 0.54 metres and a kirat is $\frac{1}{24}$ of a cubit or 2 ½ centimetres.

N.B. Minya was recorded in the reports of 1887, 0.49 too high owing to an error in assuming the value of its adjacent Bench mark.

Accuracy of records of gauges.

86. — The accuracy in recording these gauges has been very much greater than I had hoped when we consider the low state of education of the subordinates entrusted with the recording of the gauges many of whom can neither read nor write and none of whom can do more than write figures. The checks upon them are very great, and it is most remarkable to follow ten or twelve gauges down the Nile and find that a drop of 20 centimetres is duly recorded down the chain. A further check was obtained on the masonry pillars in the canals which were made in the winter of 1889. A series of daily levels were taken in August and half September, and the rise and fall of the water made by dozens of independent observers were practically the same on the pillars as those on the nearest Nile gauge. The first Assistant Engineer Muderiyah Girga Abdallah eff. Wahbi is much to be commended for his zeal, vigour, and accuracy in these interesting investigations.

Results of recording gauges.

87. — This careful gauging of the Nile has had immediate practical results. The high flood levels have been calculated and the Nile Banks carefully adjusted to the highest floods with their hitherto unknown variations in height. The flood Nile down to 30 kilometres North of Kena does not rise much over a good Nile, but in the reach Naga Hamâdi-Suhâg, the rise is excessive and the banks must be maintained at a very great height. The particular reach stands most in need of regulating heads for the canals owing to the excessive flood rise in the river.

Pillars in canal slopes.

88. — The pillars above mentioned were columns of masonry one metre square in concrete foundations. They were put in at a level of three metres above the level due to nine cubits of a rising Nile and represent practically a Nile at Aswân of 14 $\frac{2}{3}$ cubits. In some cases they were badly put in, the level-pegs having been stolen before the pillar was made. In other cases owing to the irregularity of the canal sections, the pillars were built a little away from the slopes and the current made an eddy round them which eventually undermined them.

CHAPTER VII.

Abolition of the Corvée and the introduction of Contract Work.

Final abolition of Corvée.

89. — The year 1889 will ever be memorable owing to the abolition of the Corvée or forced labour in December 1889, so that in 1890 there will be no forced labour throughout Egypt for the clearances of Canals and repairs of Banks. The Corvée was abolished in December 1889, and for L.E. 400,000, the Public Works undertake to do all earthwork repairs.

Contract Work.

90. — The repairs of the Banks and clearances of the Canals by Contract Work received a great expansion in 1889 by the permission of the "Rachat" or Redemption of forced labour in the Provinces of Asyut, Gizah, Beherah, Menufiyah, Gharbiyah, Kaliubiyah, and Sharkiyah. The Contract system had been in force for several years and in executing the work paid for by the 250,000 L.E. granted for the relief of the Corvée. Hence there was no strain nor friction and the slender Establishment of Engineers worked well in getting out the sections. The labour involved in getting real profiles of Canals to be cleared and Banks to be repaired is enormous, and in the near future much improvement may be effected in the matter of lightening the work of profiling. The lower grades of Arab Engineers are extremely slow in working and difficult to quicken and often extremely inaccurate in levelling and in appreciation of the results of a set of levels taken from a known bench-mark. Thus they will take a value of a bench-mark from the accepted lists and make either a metre error in copying it, (and curiously enough in Egypt it is generally the *metre* column that is wrong!) or commence from the wrong place in the Masonry forming the Bench mark or make some palpable error in observation of the Flood mark to which a Bank level is referred. They then proceed to plot their profiles and applying the erroneous level, proceed to

laboriously calculate on results that are seen to be false at the very first glance. I hope that by degrees we shall be able to eliminate from our staff many men who never level right and smash up their levels from sheer ignorance of how to work them.

Work in preparing contracts and quantities.

91. — The present system of referring everything before execution to the Agricultural Councils which meet in January and February has not yet ceased to be enforced and the whole establishment good, bad and indifferent descend into the field to sound canals and make profiles of Banks. The work is hurried through in October and November and the sketch estimate is ready by December to give the quantities that are to be laid before the Councils. So long as the Corvée was working it did not much matter if these profiles hastily got up by incapable men to suit the cubes required to be laid before the Council were grossly exaggerated as in the old Corvée time cubes had to be exaggerated to bring out the wished for number of men. But when the work is to be done by contract the matter is very different and some measures must be taken to get in rapidly a fairly accurate sketch estimate for the Council and then at leisure as the Contractor comes to the work accurate profiles can be given out.

Suggested improvements in preparation of estimates, etc.

92. — This important matter has not yet been finally settled, but the following appear to me to be the lines on which improvements can be made.

1) *Banks of Basins* : Observations can be made during the Flood time when the basin gives a true horizontal as to the deficiency of height or excess of height. Immediately after the discharge of the basin a reconnaissance report can be sent in as to the length in which the banks are cut about by the waves. Then all banks that are true in height and uninjured need not be levelled and profiled. The parts that are cut about can be estimated from past years experience at so much per metre run and thus approximately calculated for the Council cube. A good rule when profiling is required is to

start invariably from the same point and to take profiles at exactly equal distances say 200 metres so that when several months after the contractor takes up the work he can by measurement restore the distances and recognize the point at which the profile is taken.

Nili Canal measurements.

93. — 2) *For Nili Canals i. e. those which dry up after the Nile retires.* — These canals used to be extremely variable in section and the silt to be taken out was in the old days determined more by an instructive wish of the Mudirs and Sheikhs to take out « a good lot of silt » to be quite sure that the next Nile would rise into them, than by accurate levels referred to known states of the Nile flood. Great improvements have been made in the past four years in fixing the known levels and bed widths and it now is only necessary to sound the canals before the Nile retires and to calculate the depth of silt existing. To enable the soundings to be taken from known Bench-Marks referable to the water by inspection, there have been made this year, pillars in the slopes, the level of whose tops are known and from which the water surface of the canal can be known instantly. The bed widths of the canals are now fixed and thus by three soundings on the width of the canal we can get an extremely accurate section for the Council. When the Contractor comes he then nicks out the bed widths and the Engineer and he take check sections at every two hundred metres with three points in the width. These can be calculated from a figured list only and there is no use (as was the custom) in taking the entire canal profile over bank and in places where there was no silt. The more especially does this apply to Upper Egypt where the banks are often eight metres above bed.

Small Nili Canal measurements.

94. — 3) *For smaller Nili canals,* it may be found useful to have concrete slabs in the bed at every half kilometre to maintain the proper level and eventually a profile at every kilometre in masonry. These smaller Nili canals called *Sayyâlâhs* silt up so much when

they are dammed at their entrance to the Basins to raise their water level that I fear the bed block will never be found until after clearance and therefore will be of no use in giving an approximate estimate for the Council.

Sefi canal measurements.

95. — 4) *For Séfi canals* i. e. those which can never be quite dried and whose deposit is a wet incoherent mud, the difficulties become greater. They can only be sounded and the sounding rods sink into the mud and give a fallacious result. In the case of the larger canals which are sounded for dredging the soundings can be taken fairly accurately by a rod with a broad buttoned end. But in the smaller canals which have to be shut off before the contractor is admitted the change of section from the full to the empty canal is very great owing to the slipping of the sides and the contractor generally insists on another section being taken in the slush of the spirit level. And as the water oozing from the sides fills in the cleared portions behind the workmen, the finished work is again levelled and a second sounding is often taken after water is admitted. This matter requires much investigation so as to protect both the Government and the contractor and to ensure economy with accurate results.

Dredging measurements, etc.

96. — In dredging, the general custom is to take every fortnight careful section of the canals by soundings from the reduced level of the water referred to a bench-mark on the bank at every half kilometre and to measure up by a second set of soundings ten to fifteen days after. On the canals that have low velocity and a fair depth of 2 to 2 ½ metres, this method gives satisfactory results, but in canals of small depth or with high velocities, the sand in the bed is washed out from under the dredger's hull and re-deposited two to three hundred metres further down. If the completion measurement is taken every day near the dredger downstream there is a loss to Government and gain to the contractor and if the completion measurement is taken several days after the dredger has passed the

contractor apparently loses as he has to give over a clean bed on the day of measurement, therefore if the sand is moved by the dredger, he has to dredge deeper than the depth indicated by the profile. This matter is best settled by increasing the « limit of tolerance » to 20 centimetres i.e. if the contractor has dredged 20 centimetres too deep and the section has not been silted in by the sand disturbed by the hull of the dredger the extra 20 centimetres will be measured and paid for and redredging is not demanded for a bed too high by 20 centimetres.

Levelling instruments

97. — *Levelling instruments.* — The Cushing Levels of Cooke and Sons of York are very good and a pamphlet for their adjustment has been issued in English, French and Arabic. They are now in general use in the Public Works Department.

In the matter of repairs of levels and their accessories, we are still much behind hand. It is proposed to open a shop in the « Ecole des Arts et Métiers » so that the repairs may be satisfactorily done. To do the work of levelling properly, at least two hundred levels are required and thus repairs are constantly going on in so large a number of instruments.

CHAPTER VIII.

Maintenance.

Division of maintenance of works into three classes.

99. — The maintenance of the works connected with the irrigation of Egypt is divided into:

1) *Protection works against Flood*, such as, spurs in the river, pitching banks, stakes, sand bags, &c.

2) *Maintenance of masonry works* including. — Repairs to masonry, replacing regulating timbers, repairs to Locks, change

in form of regulation such as substituting horizontal regulation for vertical, widening the water way or raising the floors of Regulators, Inspection houses, &c.

3) *Silt clearance and embanking.* — This includes all earthwork done in Canals and Banks and on this head the greater part of the money is spent. In this, is included the cost of spurs when the spurs are made with a view to deepen the section of a Canal.

Expenditure. 99. — The following table shows the expenditure on protection works and maintenance of masonry works:

	PROTECTION.	MAINTENANCE MASONRY.
1st Circle	L. E. 4,033	L. E. 3,770
2nd »	» 10,621	» 8,574
3rd »	» 5,386	» 5,832
4th »	» 12,647	» 3,459
5th »	» 872	» 1,575
Fayum	» ...	» 1,211
Barrage	» 846	» 2,545
Totals	L. E. 34,405	L. E. 26,966

In the first Circle, the spurs in the river were not advanced during the year owing to the diversion of their funds to the *sadds* on the river.

In the second Circle, spurs were increased and strengthened and although further expenditure is required we may hope that many new ones will not be required.

In the third Circle, two new spurs were made. The sum of L.E. 2,547 remained over as a debt from 1888 for stone.

In the fourth Circle, the Ibrahimiyah spurs are not included. In Upper-Egypt, the expenditure is principally on stone for Canal heads.

Important Repairs to Masonry Works.

100. — The most notable repairs executed in 1889 to masonry works are:

	L.E.
1st Circle. — Conversion of Zagazig 9 arched Regulator to horizontal Regulation	642
Repairs Ismailiyah Locks	1,290
2nd Circle. — Shubrabas Regulator Floor Repairs	1,760
Nashart Regulator Partial Repairs	920
Lock gates to Karanen Regulator	2,000
Santa Regulator Partial Repairs	940
The Santa Regulator gave a great deal of trouble and the repair was not fully effected.	
3rd Circle. — Large repairs to the down stream holes (Bayyârah) of 8 bridges were effected by throwing in stone at a cost of	2,885
Girzah Canal head which gave a great deal of trouble in 1888 was fitted up with regulating apparatus to act both ways at a cost of	656
4th Circle. — Many bridges of the old ruinous type were fitted up with horizontal regulation, stone grooves and cills and cut stone superstructure. There were 3 in Girga, 13 in Asyut, 7 in Minya, 1 in Beni-Suef. Total 24 bridges at a cost of	3,038
5th Circle. — 12 Regulators were repaired. Of these, the Ashshi Escape was converted from 2 to 3 arches at a cost of	635
Fayum. — The Gharaq head was altered, costing	212

Accident to Membal Bridge.

101. — The Membal Bridge was undermined during the time of emptying the basins in October 1888. The difference of level was abnormal and the pitching was washed away. Unfortunately the local staff did not notice the great hole eroded below the Bridge, which is off the ordinary line of inspection, until May. It was too late to repair the Bridge in 1889 before the flood. The repairs have been put off till 1890 and the Bridge closed for the present.

MAINTENANCE OF EARTHWORK.

Total cube of earthwork.

102. — The total cube executed in 1889 is 26,292,852 m^3 or 1,554,029 m^3 more than that of 1888. The difference is not great.

The total quantities may be analyzed as follows:

Dredging by machinery.........	2,909,486 m^3;
Handwork by contract.........	15,656,036 m^3;
Handwork by unpaid labour.....	7,727,330 m^3.
Total....	26,292,852

The cube of unpaid labour is generally exaggerated by the native engineer.

Employment of Corvée.

103. — The Corvée was in force in the provinces of Kena and Esna; Girga; Minya; Beni-Suef; Fayum; Beherah; Dakahliyah.

Disposal of Corvée Relief Fund.

104. — The sum of L.E. 250,000 allotted to the Corvée Relief was differently allotted from that of 1888. Owing to the pressing nature of the *Sharaqi* works and the clearance of the Rayyah Beherah there were allotted over and above the Ordinary.

Kena and Esna............	16,000	40.000 L. E.
Girga....................	4,000	
Rayyah Beherah..........	20,000	

Employment of extra money.

105. — The extra money in the three Upper Provinces of Egypt was spent in deepening and widening the canals to put most of them on a level corresponding to 9 cubits at Aswân. So that in case of a failure like 1888 recurring, there might be 2 $\frac{1}{2}$ metres of water in each canal. As the low flood of 1888 had slightly damaged the banks, much of the money usually spent in repairing the erosion caused by the waves of the basins was spent in deepening canals also.

Attitude of the Shekhs in counsil as regards improvements.

106. — It must be clearly understood that the Agricultural councils in no way agree with the recent action of the Caisse de la Dette in limiting the Corvée work or the money of the relief of the Corvée to the maintenance in statu quo of the existing system

of canals. These Councils have for many years sanctioned the carrying out of all improvements by the Corvée and the only limit apparently was an instinctive feeling that it would be impossible to get more than a certain number of men. In recent years, when acting under the advice and control of the Inspectors of irrigation, they have approved new projects or extensive modification of old systems. Hence every year shows some much needed modification which is approved of by the *Shekhs* themselves.

Formerly perhaps these modifications took a partial form and tended more to the amelioration of the estates of large proprietors, but of recent years all projects have stood on their own merits and the most deserving and most productive of beneficial results has always been adopted. A feeling of confidence in the judgement of the Inspectors has sprung up and the *Shekhs* recognize their superior technical knowledge. At the same time, I allow that in many cases the *Shekhs* have shown remarkable technical knowledge both of the effects of an improvement and of the best technical manner of arriving at a wished for result.

In Upper Egypt, they have always wished to deepen canals and in Lower Egypt, to increase *Sefi* cultivation and dig drainage lines so that the demands of the *Shekhs* in nearly every province exceeded the means at our disposal.

The projects of widening, deepening and extension of canals indicated in the *Sharaqi Projects of 1889* will, when carried out by Loan give every man a canal deeper than he ever dreamt of, and in Lower Egypt when the new drainage Loan is sanctioned, all tracts in the Delta hitherto swampy will be drained and ready to be reclaimed and will receive summer water when it is to be had from the river.

Districts in which the Corvé have failed

107. — Up to the present, the districts in which the Corvée have decidedly failed and in which the Corvée Relief Fund has not given sufficient relief are

Minyà, Beni Suef, Beherah, Dakahliyah.

otable works f improvement effected. 108. — Among the works of improvement effected out of annual repairs may be mentioned.

1st Circle. DRAINS.

		EXPENDITURE.
Bahr el Bagar drain	L.E.	5,913
Dredging entrance into Lake Menzalah (4,122 L.E. is owing at the end of the year)	»	4,813
Drains Dakahliyah by Corvée, 325 723 m³.		

CANALS.

The Salahat canal at the Gabadah canal tail and raising banks Gabadah canal	»	2,784
Mit Tahar canal new head by Corvée, 28,000 m³.		
Widening Sahil canal for the Rayyah Taufiqi	»	2,643

2nd Circle. DRAINS.

NIL

CANALS.

Enlarging the Hutt canal for Eastern Sàhil Gharbiyah, costing	»	5,175
The Rashidiyah canal for the Western Sahil was enlarged, costing	»	1,500
The Mitberah canal	»	1,720
Also in enlarging 15 canals to suit them to the system of rotation there was spent over and above the ordinary clearance	»	5,182

3rd Circle. DRAINS.

NIL

CANALS.

The Khandaq el Gharbi was enlarged and the Khandaq es Sharki was prolonged. These *Khandaqs* are the borrow pits of the Railway from the Khatatbah canal to Damanhur. Cost	»	1,219
The Gannabiyah Khatatbah from Kafr el Eiss a high level canal	»	1,637
The Western sahil canal of Gizeh was partially excavated at a cost of	»	1,768

Dredging Ismailiyah canal.

109. — The following is a statement showing the dredging on the Ismailîyah canal, in 1st Circle for four years past :

	1886	1887	1888	1889
1. Kasr-en-Nil Branch.	67,289.75	64,597 56	nil	7,444.00
2 Shubrah Head.....	54,365.50	69,016.50	42,778.12	47,637.12
3. Shubrah to Siriaqos.	134,010.00	196,367.35	82,189.73	17,129.08
4. Siriaqos to Belbeis..	69,916.79	nil	110,934.70	109,360.86
5. Belbeis to Nefisha...	41,334.00	nil	nil	nil
6. Rayyah Menayyar.	3,000.00	10,172.00	nil	nil
Cubic Metres...	**369,916.04**	**340,153 41**	**235,902 55**	**181,571.06**

Cost of dredging 1st Circle.

110. — The following statement shows the cost of the dredging in 1st Circle for the past three years by the Egyptian Dredging Company Limited.

YEAR	CUBES DREDGED	COST
	M^3	L. E.
1887	513,850	20,139
1888	844,411	32,384
1889	610,412	24,668

A small quantity was also dredged by this Company in Menufiyah and Gharbiyah, 60,000 M^3 on the Rayyâh Menufiah, and 100,000 M^3 on the Gharbiyah drains.

Dredging Companies.

111. — The dredging of the Egyptian Dredging Company directed by Mr. Anderson has given great satisfaction this year and the sand pumps have done good work.

The Beherah Company have much improved their plant and gained much experience sand pump dredging.

Messrs. Duport and Jones have carried on the Ibrahimiyah Canal dredging smoothly and to the satisfaction of Government.

Efficiency of maintenance of the works.

112. — Although the large sum of 40,000 L.E. was diverted from ordinary repairs, the works were most thoroughly well kept in order by the money of the Corvée Ransom, Corvée relief and the Corvée themselves. The only exception is the Markaz of Abu Hummus in Beherah where there is no Corvée and the ransom is difficult to collect from the large proprietors. This year a beginning of a reform in this direction was carried out by the Ministry of the Interior and a small sum collected.

The drainage works as they are at present maintained, are either too small in section or require extensions up country to tap tracts which are more or less water-logged. It is quite impossible to do more than a very small fraction of this work, from Ordinary Repairs. After the drains have been set in order by the Loan expenditure, it will be possible to maintain them from the 400,000 L.E. allotted as a final sum, for the total suppression of the Corvée.

Rubble pitching of Banks.

113. — *Rubble pitching on bank slopes.* — This most important work, the protection of the cross banks of Upper and Middle Egypt, has made little progress in 1889 owing to the diversion of the money to *Sharaqi* Works and to the Rayyâh Beherah. It is proposed in future to allot a sum of L. E. 10,000 each year out of the 400,000 L. E. This class of expenditure saves an enormous amount in annual repairs as it is no uncommon thing to have the bank reduced to half its section by the waves in the two months of the flood. The pitching of the slopes will also diminish the number of the flood Corvée who act as watchmen and who have not been abolished like the Repairs Corvée.

The pitching also gives great security in great Floods. In 1887 many of the banks were breached solely by wave action on the North face and the bank swept away leaving only a rounded hillock 1 $\frac{1}{2}$ metres above soil and which cost 200 L. E. per kilometre to replace.

CHAPTER IX.

Original works.

Expenditure.

114. — The total expenditure on original works from the Ordinary Budget is detailed in table II of the appendix. The amount is very small compared with the needs of Egypt, but as the great works for prevention of *sharaqi* and for the completion of the drainage system will in two years complete a very large proportion of the original works. The small sum of 50,000 L.E. may be maintained for the future two years.

Works remaining to be executed.

115. — The principal remaining works of an original type leaving out the question of reservoirs and not including those works entered in the *sharaqi* Forcast and drainage Loan are:

1) Completion of the Middle Egypt system of basin Regulators.

2) Completion of the red water canals of the Ibrahimiyah system both from the Nile and from the Ibrahimiyah Canal.

3) Installation of pumps for winter and summer irrigation in Eastern Gizah.

4) Escapes and extension of summer irrigation in Kaliubiyah.

5) Regulators and Locks to replace the earthen dams annually made in the great waste water Canals of the Northern Delta.

6) Navigation in the Low Lands of the Delta.

7) *Colmatage* works in the Low Land of the Delta.

8) Extension and rectification of the Khatatbah system of Canals in Beherah to replace the Atfah pumps.

Sharaqi allotment and ordinary distribution.

116. — In 1889, owing to the urgency of the works for preventing *Sharaqi* it was resolved to allot 20,905 L. E. to the construction of syphons, escapes and regulators in Upper Egypt. The detailed list here below includes many items which were final payments of the works commenced in 1888 and previous years, and in reality in addition to the above mentioned L. E. 20,905 there was spent North of Asyut only 12,841 L. E. making a total of 33,746 L. E. for works actually undertaken during the year.

The sum of 12,841 L.E. includes:

		L. E.
4th Circle. —	Sefi Canal improvements	1,300
	Red water Canals	1,219
	Qusheshah Escape (Materials)	2,629
	Magazines and Inspection houses	382
Fayum. —	Regulators	586
	Cultivators outlets	393
1st Circle. —	*Colmatage* and Reclamation works at Tamai	2,012
2nd Circle. —	Drainage aqueducts	2,061
	Minor canal heads	170
	Inspection houses	500
3rd Circle. —	Masonry works Abu Diyàb system	1,499

Girga special works division.

117. — The large amount of work in Girga and Northern Kena rendered it necessary to make a special works Division comprising the two Northern districts of Kena (Markaz Farshut and Deshnâ) and the whole of the province of Girga. Mr. Allan Joseph, Assistant Inspector of the 1st Circle, was appointed to this temporary Division.

The masonry works designed and put in hand during 1889 were: 8 syphons, 2 escapes, 5 regulating bridges, 3 culverts.

Details of sharaqi expenditure.

118. — The details of the sum of L.E. 20,905 above mentioned.

WORK	NAME	ESTIMATED COST	EXPENDITURE 1889	PROVINCE
		L.E.	L.E.	
Syphons.	Suhag....................	18,003	4,954	Girga.
	Tahta....................	2,811	2,000	»
	Kasrah....................	13,183	5,018	»
Escapes.	Suhag....................	5,328	4,800	»
	Maksar Isna with culvert..	466	478	Kena.
Regulators.	Isharah..................	1,329	1,311	»
	Higàzah..................			»
	South Salamiyah..........			»
	Ubeydah and culvert......	600	554	».
	Khanansah culvert.......	192	192	Girga.
Miscellaneous.	Canal Pillars Girga.......	525	525	»
	do. Kena.......	476	484	Kena.
Arrears.	Rannàn syphon...........	2,047	589	»
	TOTALS... L E.	45,260	20,905	

Works given out on Ohad in 1889.

119. — The following additional works were estimated and given out to Contract during August 1889 to permit of their materials being collected. The amount spent on materials, etc., was advanced from *Sharaqi* Loan funds on an *Ohad* or advance account from the Finance Ministry. This account will be settled in 1890 :

WORK	NAME	SANCTIONED ESTIMATE	SPENT ON ACCOUNT IN 1889	PROVINCE
		L. E.	L. E.	
Syphon	Qibàh..............	1,641	370	Kena
»	Rashwaniyah.......	10,097	2.777	»
»	Tàrif..............	4,273	1,345	»
»	Zarzuriyah.........	11,014	2,135	Girga
»	Nawawrah.........	10,821	2,505	Asyut
Regulator	Magabrah..........	1,781	....	Girga
Syphon	Kasrah. } See above list	....	2,623	»
	Suhag. } See above list	....	3,100	»
	TOTALS.... L. E.		14,855	

Technical details of Sharaqi Works.

120. — The following table shows the technical details of the larger masonry works in the *Sharaqi* series.

WORK	NAME OF WORK	AREA OF WATERWAY OF SYPHON BELOW CANAL	WIDTH BETWEEN PARAPETS IN CANAL ABOVE SYPHON	HEIGHT OF REGULATING PIERS	OPENINGS IN REGULATOR		DEPTH OF FOUNDATION BELOW CANAL BED	CANAL BED AT CUBITS ASWAN	REMARKS
					N°	WIDTH OF SPAN			
		M²	Metres	Metres		Metres	Metres	Cubits	
Syphon	Suhag.......	23.6	111.7	4.25	4	3	5.30	8	Regulator in Southern canal.
do.	Tahta.......	6.32	17.20	nil	nil	nil	4.50	8	No regulator.
do.	Kasrah......	28.8	34.5	nil	8	3	5.00	8	Regulator in Nile canal.
Escape	Suhag.......	...	...	5	12	3	...	9	On to the Nile at Suhagiyah canal head.
do.	Maksar Isna.	...	...	3	2	3	...	...	On to the Nile from Ramadi canal.
Regulator	Isharah.....	...	...	$3 \frac{1}{2}$	2	3	...	...	In Hod Ballàs.
do.	Hegâzah....	...	...	$3 \frac{1}{2}$	2	3	...	...	In Hod Damàmil.
do.	Salamiyah S.	...	...	$3 \frac{1}{2}$	2	3	...	...	In Hod Salamiyah South.
do.	Ubeydah....	...	...	3	2	3	...	...	In Hod Waqf.
Syphon	Qibàh.......	6.40	14	...	...	...	4.00	9	No regulators.
do.	Tàrif.......	12.60	13.5	6.00	3	3	4.75	9	Regulator in Nile canal.
do.	Rashwàniyah	15.00	25.5	6.70	6	3	4.75	8	do. do.
do.	Zarzuriyah..	15.00	25 5	6.70	6	3	4.75	8	do. do.
do.	Nawawrah..	15.00	25.5	6.70	6	3	4.75	8	do. do.
Regulator	Magabrah...	...	...	4.75	5	3	...	...	In Hod Birba.

The Nile canal is the canal which takes from the Nile close to the syphon site. The Southern canal is the high level canal which coming from the South passes under the Nile canal by means of the syphon.

CHAPTER X.

Mapping and Levelling.

Hydrographic map of Egypt.

121. — The Cadastral Survey having been abolished, it was found desirable to form a small cadre for the completion of the Hydrographic Map of Egypt.

This cadre consists of:

M. Robert, calculator, &c.
M. Zardini } surveyors,
M. Huber }
assisted by two Arab engineers.

Map Department.

122. — The map Department has been placed under the direction of M. Ravon as head of the office assisted by four Europeans and six Arabs. The old map Department of the Ministry has been absorbed and now the former staff of Arab engineer-surveyors and the temporary staff of Europeans are under the direction of the Inspector General of Irrigation.

Mapping work executed.

123. — The mapping work executed in the Ministry in Cairo was:

124 Tracings for the technical service;
84 » for the Ministry;
27 Large copies of maps (traced);
7 Large cloth mounted maps.

In lithography the $\frac{1}{100,000}$ Arabic maps of Girga and Asyut were finished and the English copy of Asyut province and the Arabic maps of Isna put in hand. The *Sharaqi* map of $\frac{1}{200,000}$ from Aswân to Asyut was made to illustrate the Report.

A $\frac{1}{40,000}$ French-Arabic impression of the district of Shubrah in the province of Kaliubiyah, was printed. Of these maps, 117 copies were coloured by hand and mounted on cloth. They are sold for 40 P.T. each.

Field work surveys.

124. — As regards outdoor work, a superficies of 170,000 feddans in the province of Behera in the North West extremity was surveyed by M. Zardini at a cost ot $\frac{28}{40}$ of a piastre per feddan, and M. Huber carried a line of traverse round the Railways in Dakahliyah and Sharkiyah with a view of rectifying the outline and to connect with several series of triangles laid down in former years by the Cadastral Survey. A base is thus prepared for plane table rectification.

Field work levelling.

125. — In levelling the services of Messrs. Ambrosi and Stadler were employed in Kaliubiyah and the Fayum respectively to complete series of levels and suveys. The Inspector General's staff of Arab Engineers were all engaged in levelling for the *Sharáqi* works of improvement and rectification.

om Ombo and alabshah dam investigation.

126. — In November 1889, Mr. Willcocks, Inspector of Irrigation 2nd Circle, accompanied by two Arab Engineers Mohamad Fahmy and Mohamad Muhib went to examine the plateaux of Kom Ombo and Kalabshah with a view of finding out how far Mr. De la Motte's investigations had been carried. They surveyed and levelled several cross sections of the Kom Ombo plateau and found it was considerably covered over by detritus from the hills and that in the North East part a very considerable area of high sand existed. The dea of the slope of the ground being from the Nile to the hills was found to be erroneous. Thus a depth of five metres over the Nile edge of the plateau would not give the results calculated by Mr. Jacquet on Mr. De la Motte's figures. As regards the Kalabshah plateau, this was found to be far above the present Nile and the general level of the great plain is no less than 180 metres above present Nile Flood level. This effectually prevents the plain being used as a storage reservoir. The two

Arab Engineers did very good work and proved that they could make reliable reconnaissances. The investigations of Mr. Willcocks and his party have demonstrated that there can be no real storage of water to an extent that a high Flood will be sensibly diminished.

CHAPTER XI.

Agricultural Roads.

Agricultural Roads.

127. — The need of agricultural roads to facilitate the movement and transport of produce has long been felt in Egypt and, in the spring of 1889, Sir Colin Moncrieff wrote a note on the subject which decided the Ministry to take steps to put the roads in hand. Mr. Garstin who had been long pressing this subject on the Ministry got up surveys, with the aid of Mr. Brown who was specially appointed to this work. Meetings were held in Zagazig and Mansurah in the month of April at which the Mudirs of Dakahliyah and Sharkiyah, and the Notables of these two provinces discussed with Mr. Garstin and adopted his projects. The sum of 10,441 L. E. was voted in Dakahliyah and L.E. 9,196 in Sharkiyah to be collected on the land at rates varying from 2 to 3 piastres per feddan. It was decided to make one road in each minor district *markaz*. The surveys were commenced in May and finished in August, and in December after the cotton was cut the work began. It is expected that they will be completed in June 1890. From the results obtained on some local private roads of the Domains it is expected that very great assistance will be given to carriage of agricultural produce by introducing carts instead of camels.

CHAPTER XII.

The Million Loan and special extension grant.

Miscellaneous Works Million Loan.

128. — The Million Loan works including the Barrage are still under the Construction Branch of the Public Works Department. Mr. Reid who succeeded Colonel Western, C.M.G., as Director in chief, has written the following notes:

LOCK AT SHUBRABAS. — This was completed early in the year and opened for traffic.

RAYAH TEWFIKI. — The removal of the *sudds* preparatory to opening the canal was commenced and so far advanced that water was actually admitted on January 20th 1890.

The Lock and Regulator at the Bahr Moës Head were completed as also were the similar works at Gangarah.

At the Head of the Tewfiki, the Regulator and Lock were built on the foundations which had been put in during 1888 and the whole work carried to completion.

SANTA LOCK. — This work has given trouble by the breaking of the floor of the downstream portion of the lock chamber. The repairs are standing over for a convenient season.

KUDDABAH. — This work was recommenced in April and the floor of the lower lock was built before the Nile rose. The work done was then flooded for the remainder of the year.

BENHA SWING BRIDGES. — These were finished and opened for traffic.

MIT-GHAMR LOCK. — This Lock was completed and the gates set up. The works at Mit-Ghamr were ready for the admission of the Rayyah Tewfiki water by the end of the year.

KAFR DAWAR LOCK. — This Lock was completed in May under the superintendence of Mr. Foster, Inspector of Irrigation 3rd Circle. The upstream wings have cracked badly owing to unequal settlement and the lock gates would not shut. Consequently the opening of the lock was delayed till 1890.

DALGAMUN BRIDGE. — The Railway Bridge at Dalgamun crossing the Baguriyah canal was converted before the Nile rose into a swing Bridge. This gives free navigation from Cairo to the Kuddabah lock.

129. — The following is a detailed report of the work of repairing the Barrage in 1889 by Mr. Reid, the Director of works.

Barrage repairs 1889.

The work done on the Barrage during the season of 1889 consisted of the repair of the floor of the eastern portion of the Rosetta and of the fittings for gates on the eastern half of the Damietta.

On the Rosetta an exceptionally early fall in the Nile enabled work on the *sadds* to be begun on November 2nd. This was extremely fortunate as the depth of water was everywhere considerable and for a distance of 100 metres it averaged 12 metres reaching for a length of 25 metres to a depth of 15 metres.

On tipping the light soil which alone was available, it was found to take a very flat slope in the deep water, the bed of the river being appreciably raised at a distance of 100 metres from the centre line of the *sadd*. As this resulted in great expense and loss of time a pair of parallel banks were formed at 40 metres distance from one another between which the earth of the *sadd* was afterwards tipped. The upstream of these banks was made of brick rubbish and spawls and was carried up to R. L. 9.0 or 4 metres below water surface. The downstream bank was made of sand bags and was carried up to water level. In all nearly 90,000 sacks were used on the *sadds*.

The portion of the Barrage worked on was that founded on a bank of stone stated to be in one place 15 metres high. Some anxiety was felt as to whether this stone bank was silted up sufficiently to be as watertight as the surrounding river bed, as if not, it would prevent the division of the area within the *sadds* into separate ponds and it might also, by allowing a free passage to the water lying at a low level overpower the pumps. The bank however proved tight and no trouble resulted from its existence.

The dams embraced the whole of the unrepaired area of the Rosetta Barrage consisting of 39 arches and the East lock of 15 metres width. They were carried far enough to the West to enclose also four arches which had been repaired in 1887. This was done to enable any part of the unprotected end of the previous new work to be repaired should damage to it prove to have been caused by the two flood seasons which had passed since its construction.

The dam parallel to the axis of the river thus crossed the extensions to the original floor and the pitching at right angles. Downstream of the bridge, the pitching was dredged away by two Kingston's Dredgers to a depth at which, judging by the appearance of the stone, brought up, it had silted solid.

On ultimately closing the dams and pumping out the enclosed area, the downstream dam proved perfectly tight and throughout the work gave no trouble.

But the pitching crossed by the dam upstream of the bridge being very small in sectional area was not dredged away and it was further believed that as it was remote from the draw of the Barrage it would have been silted up.

Such however did not prove to be the case, and on the water inside the dams being lowered, the dam began to slip on both its outer and inner faces. A spur of earthwork was run out from the dam completely covering the pitching and when this spur had reached a length of 25 metres, the leak through the dam stopped and no further trouble ensued. For some hours however the dam was in serious danger and as the date was February 24th, an accident would have caused greater loss than the mere cost of repair.

Owing to the great depth of water in which the upstream *sadd* had to be constructed, it was determined not to make a second *sadd*, but to trust entirely to one. As the level of the water upstream had to be kept to 13.00 and the pumping inside the dams carried down to R. L. 7.75, this single dam had to withstand a head of 5.25 metres and this it did very satisfactorily for a period of four months.

On the completion of the outer dams, the enclosed area was as heretofore divided into three ponds by banks parallel to the axis of the river, and on February 24th 1890 pumping was began at 6 p. m.

The condition of the floor was found to be sounder than at any part of the Barrage previously taken up, but at the same time, owing to its having been exposed to the heaviest current of the river, its surface was more severely cut than at any other place. The brick facing was in many places cut completely through, and everywhere the surface was scored in lines 15 to 20 centimetres deep.

The usual evidences of careless treatment were found in the existence of deep holes and furrows cut by chains which having fallen, had been allowed to remain on the floor. Unless in the future the Barrage is better worked than it has been in the past, serious damage will result. With the upstream gauge maintained to R. L. 14.00, the scour will be at times very heavy, and if a chain be allowed to vibrate on the floor it will bore a hole in a single month deep enough to seriously affect the safety of the bridge.

The work done was identical with that of previous years. The floor was raised to R. L. 9.0 everywhere except under nine arches. These nine were sound, but much cut, and as their surface was already at R. L. 8.60 in the centre and 8.85 at the piers, it was found advisable to put in the new work to R. L. 9.20 so as to obviate the necessity of cutting away any of the old floor in order to make room for the new ashlar facing. This enabled the invert to be levelled up with concrete to form a bed for the new masonry.

As stated above, the work done was similar to that of previous years and consisted of the raising of the existing floor and its extension up and down stream to the same distances as before. When this was completed, a line of blocks of masonry was placed along the toe of the work done in 1887.

To enable these blocks to be put in a *sadd* was run along the down stream floor for a length sufficient to allow of five or six blocks being built and the usual enclosing dams were formed. The leakage of the gates was allowed to pass round each end of the *sadd* on the floor and the area inclosed by the *sadds* was pumped out.

The excavation for the foundations of the blocks was a severe test of the soundness of the work done in 1887, as the upstream gauge was maintained by the gates to R. L. 13.0 whilst the unwatering at the downstream edge of the apron was carried to R. L. 7.50 a head of 5.50 metres was thus put on to the work and no sign of weakness could be anywhere detected.

The total quantities of work done were :

Rubble Masonry	12.499	M^3
Concrete	3.254	»
Trieste Ashlar	319.2	»
Old Cairo Ashlar	998.4	»
Brick Work	284	»

After the rise of the river, the fittings for the new gates were erected and the Rosetta Bridge completed. With the exception of the pitching which must be added from year to year as necessity arises, the Rosetta Barrage is complete and needs only careful and skilful regulating to prove a success. At the same time the soil on which the bridge is built is so feeble, the depth of the original foundations so slight, the weight of the superstructure so great, and the pressure due to heading up so large, that any recklessness of treatment will be followed with disastrous effects.

CHAPTER XIII.

Personnel.

130. — Mr. Reid, the Director of works, has worked with his usual diligence at the Barrage and has fully maintained his reputation for good arrangements and readiness of resource.

The Inspectors of Irrigation :

Mr. Garstin, 1st Circle ;
» Willcocks, 2nd Circle ;
» Foster, 3rd Circle ;
Major Brown, 4th Circle ;
Abu's Saud bey, 5th Circle ;

have all worked their hardest. The strain of the low Nile told on the health of the four summer-water circles. I consider that the worry and troubles arising from a want of water taxes the energy of a man more than anything. The Inspectors have each their methods of working, but the results are much the same, and are becoming more and more manifest in an improved tone and efficiency of the Arab Engineers under them and a most marked improvement in the working and neatness of the Canals and Banks under their charge. The whole irrigation of Egypt depends on their careful superintendence.

Among the Assistant Inspectors and Directors of works, the following are most deserving of mention:

Mr. Allan Joseph formerly Assistant Inspector of the 1st Circle. This officer was transferred to an independent post of Director of Sharâqi works in Upper Egypt. He has carried out large masonry works over 180 kilometres of river and has been most judicious in his control of Arab Contractors. He has been much troubled with the want of arrangement of the Arab Contractor, but by constant pressure the outturn is wonderfully good. He also has got on well with the Mudirs and is in a fair way to become experienced in the carrying on of office work and accounts.

Mr. Arnold Perry formerly Assiatant Inspector 3rd Circle worked hard and conscientiously in his Circle, but his health failed him. His services have been utilized in the Ministry as Head of the Bureau Technique where his great knowledge of languages and experience in the arrangements for the steamer service will be most valuable to Government.

Mr. George Liernur has worked under Mr. Reid at the Barrage and has given very great assistance.

The other Barrage assistant Engineers, viz. Messrs. Chapman, Joseph, Sidky, Clifton, Wakefield, and Mc Killop have worked well and hard.

Mr. Langley who has been transferred to the Irrigation is a very promising young officer. The work and the country suit him and I expect that he will be of great value eventually in Irrigation.

Ismail bey Sirri the Assistant inspector of the 4th Circle has always worked well and proved himself capable of working the Circle in the absence of Major Brown.

Among the chief Engineers the following deserve notice for special excellence:

Muhamad bey Negib of Minya. His grasp of questions connected with water is specially good.

Hasan eff. Wasfi of Beni-Suef is also good all round.

Zahir bey of Beherah is a strong man with much capability of work and power of directing. He is a man of independent mind.

Muhamad bey Sabri of the Ismailiyah Canal is specially distinguished for the manner in which he gets on with Europeans.

Talaat bey of Dakahliyah is a man of much force of character and although not altogether given to accept new ideas, has great judgment in his work. His behaviour with Europeans perhaps might be better.

Ahmad bey Said of Sharkîyah has every quality necessary for a chief Engineer of the provinces. He is educated above the average speaks and writes French, and is on good terms with both Europeans and natives. He is in my opinion the best Arab Engineer we have.

Abd-ul-Wahab bey Zeki is most useful in the Rayyah Beherah dredging.

The following assistant Engineers are favorably mentioned.

1st Circle.

Hasan effendi Râghib,
Ahmad » Helmi,
Husen » Wasif,
Ali » Tâlab,
Muhamad effendi Zâhed,
» » Naim,
» » Nabîh.

2nd Circle.

Mohamad effendi Muhib,
Mohamad effendi Fahmy.

3rd Circle.

Ali effendi Shauki,
Mahmud effendi Rifki,
Abdul Magid effendi Farid,
Husen effendi Magdi.

4th Circle.

Hasan effendi Hidâyat,
Muhammad effendi Hashmat,
Ahmad effendi Fauzi,
Abderrahman effendi Wahbi,
Muhammad effendi Kâmel,
» » Wafai,
Mustafa effendi Gawdat,
» » Magad,
Muhammad effendi Munib,
» » Shahîn,
Abdallah » Wahbi of Suhag specially mentioned for his levelling.

The accountants of the 1st, 3rd and 4th Circles have done very good work.

J. C. Ross, Lieut.-Col.
Inspector General of Irrigation.

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APPENDIX **A.**

PUBLIC WORKS MINISTRY

IRRIGATION BRANCH — EXPENDITURE FOR 1889.

NAME OF WORK	OUTLAY IN 1889		OUTLAY PREVIOUS TO 1st JANUARY 1889		TOTAL OUTLAY		SPECIAL GRANT L. E. 50,000		GRAND TOTAL	
	L. E.	M.	L. E.	M.	L. E.	M.	L. E.	M.	L. E.	M.
I. — The Million Fund.										
Establishment, travelling allowances, etc.	11,953	220	50,976	087	**62,929**	**307**	...	..	**62,929**	**307**
Rosetta Barrage	72,525	770	133,365	621	**205,891**	**391**	5,768	587	**211,659**	**978**
Damietta Barrage	14,222	240	108,440	603	**122,662**	**843**	5,847	828	**128,510**	**671**
Rayah el Tewfiki... Excavation	1,680	561	204,023	707	**205,704**	**268**	56	540	**205,760**	**808**
Land	26	579	22,476	580	**22,503**	**159**	...	..	**22,503**	**159**
Barrage Station	298	416	1,166	316	**1,464**	**732**	...	..	**1,464**	**732**
Head Works	22,441	300	27,966	499	**50,407**	**799**	1,256	231	**51,664**	**030**
Two Syphons	1,436	331	8,139	442	**9,575**	**773**	228	075	**9,803**	**848**
Two Regulators,	...	..	3,465	838	**3,465**	**838**	...	..	**3,465**	**838**
Two Railway Bridges	3,848	236	13,073	022	**16,921**	**258**	96	048	**17,017**	**306**
Water Course Syphon	...	..	1,121	578	**1,121**	**578**	...	..	**1,121**	**578**
Bahr Moez Regulator	12,050	341	15,528	..	**27,578**	**341**	2,796	131	**30,374**	**472**
Gangara Works	10,334	842	8,076	.	**18,410**	**842**	...	..	**18,410**	**842**
Mit Ghamr Lock and two Regulators	...	..	25,093	001	**25,093**	**001**	3,366	..	**28,459**	**001**
Mansurah Swing Bridge	...	..	1,986	540	**1,986**	**540**	...	..	**1,986**	**540**
Kafr Badamas Lift Bridge	124	375	309	..	**433**	**375**	...	..	**433**	**375**
Lock into Nile Mansurah	12	491	23,534	400	**23,546**	**891**	...	..	**23,546**	**891**
Kalangil Lock and two Regulators	...	..	17,474	548	**17,474**	**548**	...	..	**17,474**	**548**
Anania Syphon	...	..	1,225	210	**1,225**	**210**	...	..	**1,225**	**210**
Damietta Reservoir	...	..	11,535	480	**11,535**	**480**	...	..	**11,535**	**480**
Two Drainage projects	...	..	10,908	670	**10,908**	**670**	...	..	**10,908**	**670**
Towehr project	...	..	1,000	..	**1,000**	**..**	...	..	**1,000**	**..**
Rayah Menufieh Lock	...	..	17,608	791	**17,608**	**791**	...	..	**17,608**	**791**
Baguriah Head Lock	...	..	13,562	399	**13,562**	**399**	...	..	**13,562**	**399**
Shubrabas Lock	...	..	12,191	141	**12,191**	**141**	...	..	**12,191**	**141**
Dalgamun Swing Bridge	...	..	3,197	570	**3,197**	**570**	3,000	..	**6,197**	**570**
Lock into Nile Kodaba	39	061	8,445	215	**8,484**	**276**	8,415	945	**16,900**	**221**
Santa Lock	...	..	7,598	190	**7,598**	**190**	3,000	..	**10,598**	**190**
Santa Swing Bridge	800	875	3,142	043	**3,942**	**918**	...	..	**3,942**	**918**
Bahr Saidi Reclamation	...	..	9,170	815	**9,170**	**815**	...	..	**9,170**	**815**
Mahmudieh Syphon Kilo 7	...	..	3,654	094	**3,654**	**094**	...	..	**3,654**	**094**
Kafr Dawar Lock	1	940	12,301	883	**12,303**	**823**	...	..	**12,303**	**823**
Sahel Markaz	...	..	236	980	**236**	**980**	...	..	**236**	**980**
Rosetta canal	...	..	25,021	708	**25,021**	**708**	...	..	**25,021**	**708**
Feshn Syphon and works	32	536	18,065	102	**18,097**	**638**	...	..	**18,097**	**638**
Wadi Rayan	...	..	1,263	998	**1,263**	**998**	...	..	**1,263**	**998**
Hod el Tyur	...	..	4,503	546	**4,503**	**546**	...	..	**4,503**	**546**
Bahr Wardan	...	..	259	899	**259**	**899**	...	..	**259**	**899**
Gharag Fayoum	...	..	1,061	964	**1,061**	**964**	...	.	**1,061**	**964**
Tools and Plant	1,717	..	14,280	536	**15,997**	**536**	...	..	**15,997**	**536**
	153,546	114	846,852	016	**999,998**	**130**	33,831	385	**1,033,829**	**515**

IRRIGATION BRANCH. — EXPENDITURE FOR 1889 (*continued*).

N°	DESCRIPTION OF WORK	TOTAL on each work	TOTAL in Province	TOTAL in Circle
		L.E.	L.E.	L.E.
	II.—Ordinary Budget—Original Works.			
	Kaliubiyah.			
1	Expropriation of lands....................	704	704	
	Sharkiyah.			
	Nil..................................	...	...	
	Dakahliyah.			
2	Hammama Regulator.......................	1,060		
3	Five Regulators for Tamaï Canals.........	952	2,012	2,716
	Gharbiyah.			
4	Salahib Lock Regulator..................	800		
5	Halfau Canal Pipe.......................	135		
6	Drainage pipes Berriyah..................	1,627		
7	Pitching Bahr Saidi.....................	325		
8	Inspection Houses.......................	250	3,137	
	Menufiyah.			
9	Mitbera Canal pipe......................	299		
10	Drawbridge Melig........................	170		
11	Inspection Houses.......................	250	719	3,856
	Gizah.			
12	Completion Hod Ennaza Escape............	56		
13	Completion Foot Bridge Khandak-Gharbi ..	68		
14	Expropriation of land...................	71	195	
	Carried over....	...	195	6,572

IRRIGATION BRANCH — EXPENDITURE FOR 1889 (*continued*).

N°	DESCRIPTION OF WORK	TOTAL on each work	TOTAL in Province	TOTAL in Circle
		L.E.	L.E.	L.E.
	Brought forward. ..	..	195	6,572
	Original works (*continued*).			
	Beherah.			
15	Miscellaneous Works Dinshall	83		
16	Completion Head-Sluice & Regulator Dinshall	759		
17	» Khashabi Head-Sluice	46		
18	» Head-Sluice Lower Abu-Diab	487		
19	Sundries	145		
20	Expropriation of lands	100	1,620	1,815
	Beni-Suef.			
21	Head to Selim Pasha Canal	1,300		
22	» Feshn Canal (near Abu-Shusha)	270		
23	Various small aqueducts	46		
24	Three Regulat. to branches of Amiya Canal	600		
25	Material for Kashesha Escape	2,629	5,275	
	Miniyah.			
26	Sefi Head to Abu Etza Canal	279		
27	» to Darwish Canal	270		
28	Store houses and one Inspection House	382	931	
	Asyùt.			
29	Bridges Muharraq and Qùsiyah	2,920		
30	Expropriation of lands	172	3,092	9,298
	Girgah.			
31	Syphon under Suhagiyah Canal	11,754		
32	Hod Suhag Escape			
33	Syphon under Tahta Canal			
34	Mansonry Pillars in different Canals	425		
35	Syphon under Kasrah Canal	5,018		
36	Khanansah Culvert	192		
37	Sundries	509	17,899	17,899
	Carried over....	...	...	35,584

IRRIGATION BRANCH — EXPENDITURE FOR 1889 (*continued*).

N°	DESCRIPTION OF WORK	TOTAL on each work	TOTAL in Province	TOTAL in Circle
		L.E.	L.E.	L.E.
	Brought forward....	...	...	35,584
	Original works (*continued*).			
	Fayum.			
38	Maqasim on Bahr Gharaq.................	586		
39	Cultivators outlets......................	198		
40	Iron cultivators outlets..................	195		
			979	979
	Kenah.			
41	Isharah Bank Regulator..................	1,311		
42	Gisr Higaza Regulator....................			
43	Hod Salamiyah-el-Qibli Regulator........			
44	Maksar Esna Regulator...................	478		
45	Culvert for Sayyalet Esnah...............			
46	Pillars in various Canals............	584		
47	Balance for Rannan Syphon (including land)	589		
48	Ubaidiyah Bridge.........................	554		
49	» Culvert......................			
50	Construction of Inspection House..........	400		
			3,916	3,916
	Grand Total....	...	...	**40,479**

III. — Special Expenditure.

NUBARIYAH CANAL.

OUTLAY			TOTAL
1887	1888	1889	
L.E.	L.E.	L.E.	L.E.
23,453	45,965	1,920	71,338

IV. — Expenditure on Maintenance of Works during 1889.

MUDIRIYAHS	ORDINARY BUDGET					CORVÉE FUNDS			GRAND TOTALS	
	REPAIRS TO MASONRY	PROTECTION AGAINST INUNDATION	TEMPORARY DAM IN NILE	PETTY REPAIRS	SURVEYING	CORVÉE RELIEF	CORVÉE RANSOM	ROSETTA BARRAGE	FOR 1889	FOR 1888
	L. E.	L. E.	L. E.	L. E.	L. E.	L. E.	L. E.	L. E.	L. E.	L. E.
Kaliubiyah..........	995	2,721	...	...	...	12,452	10,898	...	27,066	17,783
Sharkiyah...........	2,175	...	...	...	...	18,847	17,217	...	38,239	34,672
Dakahliyah..........	600	1,312	13,183	232	...	22,942	7,869	...	46,138	44,121
Gharbiyah...........	3,922	7,563	...	...	...	24,169	25,143	...	50,797	50,319
Menufiyah	4,652	3,058	1,429	198	...		23,570	...	42,907	37,609
Beherah...	4,700	5,006	4,398	...	...	11,233	7,665	6,427	39,429	32,397
Gizah	1,132	380	...	388	...	32,255	6,732	...	40,887	49,661
Beni-Suef............	628	2,498	...	...	...	8,562	1,197	...	12,885	11,818
Minyah.............	481	701	...	...	...	10,972	1,750	...	13,904	13,118
Asyut...............	1,600	8,498	...	106	...	32,838	21,302	...	64,344	74,087
Girgah.............	750	950	...	...	...	15,513	22	...	17,235	17,623
Fayum.............	1,211	...	...	...	...	5,958	...	...	7,169	8,018
Kenah	1,575	872	..	9	...	45,830	23	...	48,309	30,457
Barrages............	2,545	846	1,557	...	...	776	...	...	5,724	7,689
Central administration	...	...	...	...	535	...	...	...	535	11,635
Totals...	**26,966**	**34,405**	**20,567**	**933**	**535**	**242,347**	**123,388**	**6,427**	**455,568**	**440,997**

IRRIGATION BRANCH — EXPENDITURE FOR 1889 *(continued)*.

V. — Amount of Earthwork executed in 1889 in the clearance of Canals and Drains, and the maintenance of embankments.

PROVINCE	WORK DONE BY CONTRACT			WORK DONE BY CORVÉE	TOTAL WORK DONE BY CONTRACT AND CORVÉE
	CORVÉE RELIEF	CORVÉE RANSOM	TOTAL CONTRACT		
	Cubic Metres	Cubic Metres	Cubic Metres	Cubic Metres	Cubic Metres
Kaliubiyah......	256,323	604,723	861,046	118,709	979,755
Sharkiyah.......	439,308	1,015,623	1,454,931	...	1,454,931
Dakahliyah......	659,644	154,923	814,567	1,153,957	1,968,524
Menufiyah.......	96,085	882,824	978,909	...	978,909
Gharbiyah.......	1,013,246	1,573,429	2,586,675	...	2,586,675
Beherah.........	777,145	488,263	1,265,408	3,882	1,269,290
Gizah...........	1,404,896	563,771	1,968,667	...	1,968,667
Fayum..........	341,693	...	341,693	520,853	862,546
Beni-Suef........	446,334	62,479	508,813	789,917	1,298,729
Miniah....	685,948	110,873	796,821	1,306,760	2,103,581
Asyut	1,382,910	1,551,946	2,934,856	...	2,934,856
Girgah..........	1,043,915	...	1,043,915	2,166,515	3,210,430
Kenah	2,970,669	1,500	2,972,169	1,626,738	4,598,907
Frontier.	37,051	...	37,051	40,000	77,051
TOTALS...	11,555,168	7,010,354	18,565,522	7,727,330	26.292,852

VI. — Payment to Behera Irrigation Society for supply of water in that province.

	OUTLAY		
	1889	1888	1887
	L.E.	L.E.	L.E.
Fixed annual sum.....................	26,320	26,320	26,320
Supply of water at Atfeh...............	14,405	16,159	10,073
» » Khatatbeh	19,274	18,776	17,458
TOTAL.... L.E.	59,999	61,255	53,851

VII. — Corvée Statistics for 1889.

PROVINCE	N° OF CORVÉE FOR 100 DAYS	N° WHO RANSOMED THEMSELVES	WORK DONE BY CORVÉE	WORK DONE BY CONTRACT			TOTAL WORK DONE CORVÉE AND CONTRACT	EXPENDITURE CORVÉE RELIEF	EXPENDITURE FOR RANSOM FUND	TOTAL EXPENDITURE	N° OF CORVÉE FOR 100 DAYS IN 1883
				CORVÉE RELIEF FUND	RANSOM FUND	TOTAL CONTRACT WORK					
			Cubic metres	Cubic metres	Cubic metres	Cubic metres	Cubic metres	L.E.	L.E.	L.E.	
Kalioubieh. . . .	1,059	23,508	118,709	256,323	604,723	861,046	979,755	10,867	10,898	21,765	7,621
Sharkieh.	...	36,055	...	439,308	1,015,623	1,454,931	1,454,931	16,018	17,217	33,235	18,238
Dakahlieh.	8,662	4,606	1.153,957	659,644	154,923	814,567	1,968,524	21,865	7,869	29,734	20,605
Menoufieh.	...	54,712	...	96,085	882,824	978,909	978,909	4,268	23,300	27,568	26,887
Gharbieh	...	63,671	...	1,013,246	1,573,429	2,586,675	2,586,675	19,901	25,413	45,314	25,093
Behera.	32	22,096	3,882	777,145	488,263	1,265,408	1,269,290	17,660	7,666	25,326	8,172
Giseh.	...	21,447	...	1,404,896	563,771	1,968,667	1,968,667	52,255	6,730	58,985	5,929
Fayoum	3,143	...	520,853	341,693	...	341,693	862,546	5,957	...	5,957	6,255
Beni-Souef.	4,161	3,990	789,916	446,334	62,479	508,813	1,298,729	8,551	1,197	9,748	8,217
Minieh.	8,541	5,833	1,306,760	685,948	110,873	796,821	2,103,581	10,986	1.750	12,736	11,898
Assiout	...	71,003	...	1,382,910	1,551,946	2,934,856	2,934,856	32,831	21,301	54,132	25,668
Girgeh.	11,257	83	2,166,515	1,043,915	...	1,043,915	3,210,430	15,447	25	15,472	15,366
Keneh & Esneh.	13,049	172	1,666,738	3,007,721	1,500	3,009,221	4,675,959	45,369	22	45,391	22,637
TOTALS. . .	49,904	307,176	7,727,330	11,555,168	7,010,354	18,565,522	26,292,852	261,975	123,388	385,363	202,586

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REPORT

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FOR THE YEAR 1890,

BY

LIEUTENANT-COLONEL JUSTIN C. ROSS, C. M. G.
INSPECTOR GENERAL OF IRRIGATION, EGYPT.

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REPORT FOR THE YEAR 1890.

REPORT

OF THE

ADMINISTRATION OF THE DEPARTMENT OF IRRIGATION

FOR THE YEAR 1890.

CHAPTER I.

Nile Flood of 1890 and Basin Irrigation.

State of Nile Flood.

1. — The Nile Flood of 1890 was a very high one, though late in arriving. It was also very late in falling, so that in the last fortnight of October, there were many basins in which the low lands were not properly drained and fears were felt for a loss of crops owing to late sowing time. These fears were not well founded. The extreme flood limit was only 4 kirats or 9 centimetres below that of the great flood of 1887.

The two can thus be compared by the dates on which the Nile passed each cubit at Aswan (a cubit = 54 centimetres).

CUBITS	DATE	
	1887	**1890**
14 ..	5th August ..	7th August
15 ..	7th » ..	12th »
16 ..	9th » ..	19th »
17 ..	14th » ..	23rd »

The extreme flood of 1887 was on the 1st September, 17p. 21k.
That of 1890 was on the 2nd September, 17p. 17k.

The 1887 Flood was one of much greater volume. This will be seen from the following figures :

In 1887, the river remained above 17 cubits at Aswan, 36 days.
» 1890, » » » » 17 » » » 11 »
» 1887, » » » » 16 » » » 53 »
» 1890, » » » » 16 » » » 38 »

Thus a much greater volume passed down the river in August and September than in 1890.

The basins were not so much filled nor were the banks breached in 1890, and the excessive swelling of the river after the Nile had gone down at Aswan was not so marked below Asyut as in 1887.

Comparison of 1890 with 1887.

2. — This after-swell of the river was not noticeable between Aswan and Kena and very little between Kena and Asyut.

In the following table, the extreme height attained on the different gauges is shown as contrasted vith the extreme height of 1887. This extreme gauge is not natural. It is caused either by the diminution of the flow of water into the basins or by the overflow of the basins into the Nile, either by breaches or by reduction through the escapes.

NAME OF GAUGE	R. L. OF FLOOD		DIFFERENCE 1890 BELOW 1887	
	1887	1890		
Aswan	93.81	93.72	— 0.09	
Kilh	84.05	83.71	— 0.34	
Armant	78 99	79.14	+ 0.15	This is clearly an error as shown in other list.
Gebelaw	73.81	73.82	+ 0.01	Ditto ditto ditto
Ramman	71.76	71.24	— 0.52	
Naga Abu Hamad	69.74	68.80	— 0.94	
Abu Shusha	66.70	66.46	— 0.24	0.25 over the natural flood of 1890.
Suhag	62.22	61.55	— 0.67	
Asyut	52.86	52.64	— 0.22	0.19 ditto ditto
Minyah	39.96	39.50	— 0.46	
Wastah	26.74	26.32	— 0.42	0.32 ditto ditto
Cairo (Rodah)	20.63	19.82	— 0.81	0.38 ditto ditto

The Flood of 1887 seems to have been wrongly read at Abu-Shushah and Asyut.

The Kilh Gauge has been determined to be 0.60 lower than the values given to it in reports of 1887, 1888 and 1889. The new value is used in the 1890 Report.

Filling of the basins.

3. — The filling of the basins has not been sufficiently studied, as, up to the present year, the basins used to be filled in very different ways. Some were well situated either at the end of a chain or on a side channel from the main lines. These were filled early in the season and remained full throughout the season. Again of these, some had bridges for reduction of supply and thus they enjoyed the benefit of the water passing through and depositing mud all through the year. Those that had no bridges for reduction were held at a low level for fear of breaching and thus their upper ends were left dry till the last week of the season. In other basins, one corner was out of the way of the current and the rich red stream passed through the centre or the other side of the basin, leaving the retired corner with nothing but water whose mud was strained through the grass and other vegetable growths of the land surface. These irregularities of delivering the water would have been much more pronounced, were it not that the Nile, when it rises over 18 cubits at Aswan, can pass directly into each basin and thus for the brief period of an average rise above 16 cubits, the upper part of the basins got a supply straight from the Nile instead of from the upper basins after the mud has settled.

Much has been done on the Ibrahimiyah Canal to remedy this by red water feeders either from the Nile or from the Canal. In Upper-Egypt, the Canals of supply have been taken on to the alluvial Bank and made to deliver their water direct into each basin of a chain.

By grading the borrowpits of banks also, lines of flow have been set up by which the red water is carried round the basin edge and delivered at hundreds of points.

Delivery of red water.

4. — This multiplication of the points of delivery cannot be too much insisted on and even after the whole remodelled series of Canals has been completed, there will still remain the study of the minor distributing channel. The importance of this may be inferred from the fact that where red water has been brought straight into a corner which has not enjoyed it, the yield is increased by upwards of 500 lbs of grain per acre or say 8 bushels.

Tabular atements of ress of Filling basins.

5. — In order to fix this matter of filling by statistics and thereby to allow comparisons to be made for future years, the table No. 1 is drown out. The statistics are difficult to get, as the Bridges on which the measurements are made, are isolated and the men in charge not trained to write gauges or make observations. The first set of tables shows the general view of the basins filling as reported by the District Engineers in the Girga Mudiriyah. The date of the entrance of the water is shown. Then the date of reaching Full Irrigation or "Tamam er Rayy". Then the date of Flood, i. e. when the guardians thought there was too much in the basin and a reduction was felt to be necessary. This is termed "Izdiham" in Arabic. The word means here strain or overpressure. The pressure is not necessarily at the same time as the reduction or "Takhfif" for the reduction may be so carried on as to avoid any pressure. The matter is a most vital one for study as the subordinate staff get into a most anxious state of mind when they find a basin rising inspite of their efforts to keep it down. (I regret to say that this year, it was not only the subordinate staff who were panic-stricken, but the Mudir of Asyut himself, who ought to have known better, kept sending off telegrams of the most alarming character to Cairo. The Irrigation authorities of the Circle knew better by their gauges and much confusion was averted by the steadiness of the Suhag Engineers who regulated their supply most carefully).

The table is completed by the date of emptying "Sarf" and the water level at the time of "Sarf" upstream and downstream of the basin. This is very useful for data as to the conditions of discharge and consequent action on the Bridge floors and downstream aprons.

The second table gives for selected Bridges the height of the water once a week, and is abstracted from the daily record kept at each bridge.

Mr. Allan Joseph in Suhag has made a special study this year of the data for the first table.

There can be no doubt that, generally speaking, the difficulties of basin filling regulation and emptying have chiefly arisen from want of proper Canals to fill the basins and want of bridges to regulate them when filled or to empty them under control.

It is confidently hoped that by 1892, many of these difficulties will have been overcome by the completion of the very large number of regulators and escapes in Upper-Egypt.

The second Nile Flood Table shows the list of escapes.

Escapes on to Nile.

6. — The list of escapes (See page 12) on to the Nile existing in Upper-Egypt shows the dates on wich "Takhfif" or reduction of water from the basin to the Nile began and the date of beginning of "Sarf" or Emptying. It also shows in as many cases as is known, the reduced levels of the basin and Nile at the time of emptying "Sarf". It is very valuable as showing the varying conditions under which these Nile Escapes act.

Regulating bridge gauges in the basins.

7. — The third Nile Table shows the gauges at a number of Bridges in Upper and Middle-Egypt taken from the daily record. The entry is given once a week during the Flood. This table (See pages 14 and 15) is of great value as it shows the Full Irrigation in level and the time taken to reach it. It thus shows at a glance which basins are well supplied and which basins are filled too slowly.

Table No. 1 *showing the various dates of the filling and emptying the basins in the Girga Province Nile Flood 1890.*

NAME OF BASINS	DATE OF WATER ENTERING THE BASIN	FULL IRRIGATION (TAMAM ER RAYY)		PRESSURE ON BANKS		REDUCTION MADE DATES			EMPTYING OR SARF		DIFFERENCE IN LEVEL BETWEEN BASIN	NAME OF BRIDGE OF SARF OR CANAL	SERIAL NUMBER IN CHAIN
		DATE	LEVEL	DATE	LEVEL	1st	2nd	3rd	DATE	WATER LEVEL			
Beni Himel West......	Aug. 15	Aug. 31	65.60	Sept. 13	65.64	Sept. 1st	Sept. 13	....	Nov. 2	64.90	0.75	Kasrah Canal	...
Beni Himel East.......	» 29	» 31	65.60	» 11	65.75	» 1st	» 11	....	Oct. 9	65.17	0.10	Bardis	....
Hod Bardis............	» 15	Sept. 20	65.25	....	...	....	....	....	» 9	64.88	0.93	Birba	....
Hod Birba.............	» 16	» 12	64.00	Sept. 15	64.27	....	....	....	» 8	64.01	0.66	Araba	....
Hod Araba............	» 17	» 15	63.85	» 17	64.04	Sept. 17	....	....	» 5	63.76	0.84	Suhag	....
Hoshet Khanansah....	» 17	» 9	62.32	....	...	....	....	....	» 10	62.30	0.15	Suhag	....
Hoshet-el-Kawâmil....	» 21	» 15	62.73	....	...	....	....	....	» 5	62.55	0.10	Suhag	....
Hod Suhag............	» 12	» 17	62.78	Sept. 22	62.69	Sept. 21	Sept. 22, 23	Sept. 30, Oct. 1st	» 4	62.39	...	....	....
Hod Sâhél Baliana.....	» 13	Aug. 28	65.34	» 2	65.66	....	....	....	» 8	64.88	0.33	Um el Tubal.....	....
Hod Gez Khalafiyah..	» 17	» 31	64.81	....	...	....	....	....	» 8	64.70	...	....	....
Hod Himedi & Bayyadi.	» 17	» 23	64.33	Aug. 31	64.85	Aug. 31	....	....	» 8	64.60	0.46	Zarzur Canal	....
Hod Khalafiyah........	» 18	Sept. 18	64.58	Sept. 22	64.83	Sept. 22	....	....	» 9	64.45	0.44	Birba	....
Hoshel Isayrât.........	» 17	» 12	63.96	....	...	....	....	....	» 7	64.07	0.65	Araba	....
Hod Hikr..............	» 20	» 23	63.75	Sept. 24	63.96	Sept. 26	....	....	» 6	63.78	...	....	....
Hod Sahil Tukh.......	» 21	» 24	63.86	....	...	» 26	....	....	» 6	63.72	...	....	....
Hod Lahawah & Kharifah	Sept. 12	» 27	63.52	....	...	....	....	....	» 7	63.30	0.65	Zarzuriyah Canal	....
Hod Bagiyah..........	Aug. 21	» 4	63.05	....	...	....	....	....	» 6	62.60	0.10	Zarzuriyah Canal	....
Hod Harizat...........	Sept. 17	» 27	62.60	....	...	....	....	....	» 6	62.45	0.15	Hod Suhag	....
Hod Menshiyah E. & W.	Aug. 14	» 24	63.00	Sept. 25	62.90	....	....	....	» 6	62.40	0.04	Suhagiyah	....
Hod Gez-el-Muntasar..	» 14	» 4	62.90	» 5	63.00	Sept. 5	....	....	» 6	65.40	0.60	Nile	....
Hod Iraba and Idfu....	» 12	Oct. 1st	61.25	....	...	....	....	....	» 2	61.25	2.80	Suhagiyah	....
Hod Gharizat..........	» 12	» 3	59.70	....	...	....	....	....	» 12	...	...	....	....

Hod Aulad Nuser......	Sept. 14	» 26	61.30	....	...	....	....	....	» 7	61.15	0.20	Um Alilat	....
Hod Naga Tamam	Aug. 13	» 30	60.80	....	...	....	....	....	» 7	60.80	0.36	New um Alilat	...
Hod Samarnah........	» 13	Oct. 5	60.35	....	...	....	....	....	» 7	60.40	0.88	Benawit	....
Hod Benawit..........	» 14	» 3	59.34	....	...	....	....	....	» 6	59.16	0.33	Enabis	....
Hod Beni Hilâl........	» 14	Sept. 15	59.11	....	...	Sept. 20	....	....	» 6, 22	59.08	1.00	Nile	....
Hod Kom Bader W....	» 13	» 8	58.05	....	...	....	....	....	» 3	57.42	0.49	Suhagiyah	....
Hod Um Dômah W....	» 13	» 4	56.73	Sept. 7	57.27	Sept. 8	....	....	» 5	56.36	0.54	Suhagiyah	....
Hod Enebis............	» 13	» 20	58.82	....	...	....	....	....	» 6	58.82	1.62	Kom Badr East	...
Hod Sawamah W.	» 14	» 11	58.41	Sept. 17	58.78	....	....	....	» 6	58.45	0.36	Nile	....
Hod Banahu W.	» 13	Aug. 23	58.26	....	...	....	....	....	» 6	58.62	0.06	Benaga	....
Hod Banaga W........	» 13	Sept. 7	58.24	....	...	Oct. 1st	....	....	» 6	57.88	0.50	Mabruer	....
Hod Banahu E.........	» 15	Aug. 27	58.60	....	...	....	....	....	» 1st	58.53	...	....	....
Hod Banaga E.........	» 15	» 27	58.60	....	...	....	....	....	» 1st	58.53	...	....	....
Hod Madmar W.......	» 15	Sept. 1st	57.36	Sept. 6	57.64	Oct. 2	....	....	» 5	57.32	1.00	Um Dômah East	....
Hod Madmar & Tuna E.	» 15	» 9	57.51	....	...	Sept. 2	....	....	» 5	56.65	0.33	Um Dômah East	....
Hod Gez. Shatural.....	» 16	Aug. 31	57.86	Sept. 4	57.94	» 1st	....	....	» 6	57.50	...	....	....
Hod Gez. Mishta	» 16	» 31	57.71	» 4	57.85	» 1st	....	....	» 6	57.38	...	....	....
Hod Qaw-el-Gharl.....	» 16	» 27	57.32	» 4	57.82	» 1st	....	....	» 6	57.30	1.11	Nile	....
Hod Kom Badr E......	» 13	Sept. 5	57.87	» 8	57.95	» 8	....	....	» 4	57.40	0.38	Suhagiyah	....
Hod Um Dômah E.....	» 13	» 7	56.90	» 9	57.10	» 4	Sept. 11	Sept. 13, 17	» 5	56.32	0.71	Hod Beni Siuèa	...
Hod Balabish..........	» 15	» 11	67.13	....	...	....	....	....	» 12	66.80	0.35	Khiyam	....
Hod Khiyam..........	» 15	» 11	66.82	....	...	....	....	....	» 12	66.44	0.50	Magalâl	....
Hod Hamamah & Mazatah	» 15	» 7	66.25	....	...	Sept. 21	Sept. 26	....	» 11	65.42	0.85	Awlad Yehya	....
Hod Aulâd Yahyê.....	» 15	Aug. 31	64.96	Sept. 2	65.44	» 2	....	....	» 10	64.55	...	....	....
Hod Akhmim..........	» 15	Sept. 10	61.86	» 13	62.01	» 13	Sept. 20	....	» 12	61.64	...	....	....
Hod Sawâmah E.	» 15	» 14	61.09	....	...	» 14	....	....	» 11	60.98	...	....	....
Hod Sawâmah W.....	» 14	» 9	60.88	....	...	» 8	....	....	» 11	60.60	...	....	....
Hod Kitkâtah.........	» 14	» 3	60.05	Sept. 7	60.21	....	....	....	» 10	59.52	...	....	....
Hod Galawiyah........	» 16	Aug. 30	59.42	» 1st	59.60	....	....	....	» 11	59.60	0.91	Nile	....

Table No. 1 (Continued) *showing the various dates of the filling and emptying the basin in the Kina Province Nile Flood 1890.*

NAME OF BASINS	DATE OF WATER EMPTYING THE BASIN	FULL IRRIGATION (TAMAM ERRAYY)		PRESSURE ON BANKS		REDUCTION MADE DATES			EMPTYING OR SARF		DIFFERENCE IN LEVEL BETWEEN BASINS	NAME OF BRIDGE OR SARF OR CANAL	SERIAL NUMBER IN CHAIN
		DATE	LEVEL	DATE	LEVEL	1st	2nd	3rd	DATE	WATER LEVEL			
Hod Binbân...........	Aug. 1	Sept. 15	90.09	..	..	..	..	..	Oct. 6	..	..	Binban Canal	....
Hod Ramadi S........	» 13	» 15	86.287	..	..	..	..	..	» 1	..	..	Ramadi Canal	....
Hod Ramadi N........	» 13	» 15	85.411	..	..	Sept. 7	..	..	» 1	..	..	Do.	....
Hod Idfu and Kilh.....	» 13	» 15	84.897	..	..	» 13	..	..	» 1	..	..	Do.	....
Hod Sibaiyah	» 13	» 15	82.026	..	..	..	..	..	» 5	..	..	Do.	....
Hod Namasâ	» 13	» 15	81.762	..	..	..	...	..	» 4	..	..	Do.	....
Hod Isnâ S............	» 13	» 15	81.342	..	..	Sept. 16	..	..	» 3	..	..	Do.	....
Hod Isnâ N. and Asfûn.	» 11	» 15	79.817	..	..	..	..	..	» 2	..	..	Um Adas Ramadi	....
Sawâhil Matâ'nah	» 17	» 15	..	..	..	..	..	..	..	..	..	Do.	....
Sawâhil Armant.......	» 17	» 15	..	..	..	..	..	..	..	..	..	Asfûn	....
Hod Kimân............	» 12	» 15	79.547	..	..	Sept. 6	..	..	Oct. 2	..	..	Um Adas	....
Hod Mâhamid.........	» 17	» 15	78.074	..	..	» 8	..	..	» 3	..	..	Asfûn	....
Hod Riti	» 18	» 15	78.465	..	..	» 7	..	..	» 2	..	..	Do.	....
Hod Makharr..........	» 18	» 15	..	..	..	..	..	..	» 1	..	..	Do.	....
Hod Dabiyah	» 19	» 15	76.615	..	..	..	..	..	» 2	..	..	Do.	....
Hod Danfiq............	» 12	» 15	75.734	..	..	Sept. 9	..	..	» 3	..	..	Fadiliyah	....
Hod Akhmâs..........	» 12	» 15	76.075	..	..	..	..	..	» 3	..	..	Do.	....
Hod Qâmulah	» 12	» 15	76.075	..	..	..	..	..	» 3	..	..	Do.	...
Hod Khattârah	» 12	» 15	75.320	..	..	..	..	..	» 6	..	..	Do.	....
Hod Tukh.............	» 12	» 15	74.920	..	..	..	..	..	» 6	..	..	Do.	....
Hod Zawâidah.........	» 13	» 15	74.230	..	..	..	..	..	» 5	..	..	Tukh	....
Hod Ballâs.............	» 13	» 15	74.200	..	..	..	..	..	» 4	..	..	Do.	....
Hod Tuwairât.........	» 13	» 15	73.747	..	..	..	..	..	» 7	..	..	Do.	....
Hod Tarâmsah........	» 14	» 15	73.667	..	..	..	..	..	» 7	..	..	Do.	....
Hod Dandarah.........	» 12	» 15	72.80	..	..	..	..	..	» 11	..	..	Dêr Canal	....
Hod Marâshdad.......	» 23	» 15	70.820	..	..	..	..	..	» 10	..	..	Dêr and Marashdah	....

Hod Gharablî	» 20	» 15	[illegible]	..	..	..	..	..	» 5	..	..	Rannân and Rashwaniyah	....
Hod Dêr	» 15	» 15	67.70	..	..	Sept. 3	..	..	» 6	..	..		....
Hod Bahgurah	» 13	» 15	68.00	..	..	» 7	..	..	» 6	..	..		....
Hod Bakhânis	» 19	» 15	67.80	..	..	» 18	..	..	» 3	..	..		....
Hod Raqâiq	» 12	» 15	67.50	..	..	..	..	..	..	..	..		....
Hod Sahharah	» 12	» 15	68.00	..	..	..	..	..	Oct. 7	..	..		....
Hod Mussalleb	» 11	» 15	67.80	..	..	Sept. 13	..	..	» 4	..	..		....
Hod el Kôrn	» 20	» 15	67.20	..	..	» 16	..	..	» 3	..	..	Rannân	....
Hod Samhûd	» 15	» 15	66 70	..	..	» 12	..	..	..	..	..	Damrâniyah	....
Hod Khattarah	» 1	» 15	92.53	..	..	..	..	..	..	..	..	Khattarah	....
Hod Drâw	» 1	» 15	90.22	..	..	..	..	..	..	..	..	Draw	....
Hod Ridisiyah S.	» 12	» 15	..	..	..	..	..	..	Oct. 3	..	..	Ridisiyah	....
Hod Ridisiyah N.	» 12	» 15	..	..	..	..	..	..	..	..	..	Do.	....
Hod Hillah and Der	» 16	» 15	81.08	..	..	..	..	..	Oct 5	..	..	Killabiyah	....
Hod Shaghah	» 16	» 15	79.04	..	..	..	..	..	» 6	..	..	Do.	....
Hod Salamiyah S.	» 15	» 15	79.04	..	..	Sept. 1	..	..	» 6	..	..	Do.	....
Hod Salamiyah N.	» 15	» 15	78.92	..	..	» 1	..	..	» 6	..	..	Killabiyah & Maâllat	....
Hod Gabbanah	» 13	» 15	78.36	..	..	..	..	..	» 15	..	..	....	....
Hod Hibil W.	» 26	» 15	77.23	..	..	..	..	..	» 15	..	..	....	....
Hod Hibil E.	» 26	» 15	77.57	..	..	..	..	..	» 15	..	..	....	....
Hod Karnak W.	» 13	» 15	76.96	..	..	..	..	..	» 6	..	..	....	....
Hod Karnak E.	» 13	» 15	77.39	..	..	..	..	..	» 6	..	..	Mâalah & Bayyadiyah	....
Hod Higâzah	» 14	» 15	75.756	..	..	Sept. 4	..	..	» 10	..	..	Bayyadiyah Canal and Shanhuriyah Canal	....
Hod Damâmil	» 14	» 15	75.856	..	..	..	..	..	..	..	..		....
Hod Ashshî	» 14	» 15	76.955	..	..	Sept. 4	..	..	..	..	..		....
Hod Farrâsh	» 14	» 15	75.576	..	..	» 4	.	..	..	..	..		....
Hod Qift	» 10	» 15	75.210	..	..	» 7	..	..	..	..	..		....
Hod Binud	» 10	» 15	73.953	..	..	» 1, 3	..	..	..	..	..		....
Hod Gabalâw	» 10	» 15	73.761	..	..	Aug. 31	..	..	..	..	..		....
Hod Makhâdmah	» 10	» 15	73.00	..	..	..	..	..	..	..	..		....
Hod Qanâwiyah	» 14	» 15	72.85	..	..	..	..	..	..	..	..		....
Hod Awlâd and Amr	» 14	» 15	72.63	..	..	Aug. 30	..	..	..	..	..		....
Hod Gimmezah	» 12	» 15	71.26	..	..	..	..	..	..	..	..	Ghilâsi	....
Hod Abu Diyâb	» 12	» 15	71.58	..	..	Aug. 28	..	..	..	..	..	Do.	....
Hod Samata	» 15	» 15	71.49	..	..	» 31	..	..	..	..	..	Ghilâsi and Samata	....
Hod Dishnâ	» 12	» 15	70.93	..	..	» 28	..	..	..	..	..	Ghilâsi	....
Hod Hamad	» 12	» 15	70.64	..	..	Sept. 6	..	..	..	..	..	Ghilâsi and Samata	....
Hod Qasr & Salaniyah	» 14	» 15	..	..	..	..	..	..	..	..	..	Mahmudiyah	....

Nile Flood Table No. 2 *showing gauges at the Nile Escapes between Aswan and Cairo.*

Name of Escape	1884			1885			1886			1887			1888			1889			1890		
	Date	Basin	River	Date	Basin	River	Date	Basin	River	Date	Basin	River	Date	Basin	River	Date	Basin	River	Date	Basin	River
Kilh	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Oct. 1	85.77	83.31	Oct. 4	84.88	83.61
Diqqêrah	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Sept. 26	81.73	81.40
Maksar Isnâ	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Sept. 16	81.39	80.84
Mahgar Salamiyah	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Sep. 28	78.70	77.58	Sept. 1	78.99	78.45
Gebelên	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Oct. 3	79.57	78.39	Oct. 2	79.28	78.98
'Ashshi	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Oct. 5	76.80	75.13	Oct. 7	76.95	76.45
Danfiq	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Oct. 4	75.75	74.21	Sept. 9	75.73	75.25
Gebelaw	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Oct. 7	73.97	72.23	Oct. 8	73.58	72.62
Tarâmsah	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Oct. 5	73.23	72.25	..	..	..
Hamad	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Oct. 10	70.97	68.73	Oct. 12	70.30	68.88
Haw	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Oct. 17	69.75	67.66	Sept. 10	69.76	69.10
Abu Shushah	..	..	..	..	..	..	..	..	..	..	..	..	Oct. 5	65.99	64.00	Sept. 30	66.71	65.66	Sept. 10	66.70	66.30
Awlâd Yahyâ	..	..	..	Oct. 2	64.98	63.23	Oct. 7	65.00	63.23	..	..	..	Oct. 23	64.24	60.90	Oct. 8	64.98	63.50	Oct. 10	64.55	63.90
Suhâg Bank	..	..	..	Sept. 28	62.50	60.50	Oct. 4	62.78	60.64	Oct. 7	63.23	62.27	..	..	..	Oct. 1	62.93	60.91	..	..	..
Suhag Escape	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Oct. 4	62.39	61.25
Galawiyah	..	..	..	Oct. 6	59.70	59.00	..	..	..	..	..	..	..	..	..	Sept. 22	59.52	59.10	Oct. 11	59.30	58.39
Abutig Bank	Oct. 29	53.50	52.91	Oct. 6	54.67	53.61	Oct. 10	54.89	54.15	Oct. 6	53.69	54.90	Oct. 28	54.24	50.61	Oct. 12	55.64	53·54	Oct. 7	55.38	53.97
Abu Tig	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Salim	Oct. 19	54.23	50.61	Oct. 7	54.33	51.44	Oct. 13	53.73	51.35	Oct. 7	53.72	52.00	Oct. 28	53.79	48.30	Oct. 12	54.04	52.18	Oct. 7	53.62	52.53
Matmar	Oct. 18	54.58	52.70	Oct. 12	56.20	53.80	Oct. 13	56.33	54 10	Oct. 13	56.23	53.80	Oct. 24	53.00	53.00	Oct. 10	55.12	54.00	Oct. 10	54.48	54.03
Ma'âbdah Bank	Oct. 25	49.70	46.71	Oct. 11	50.00	47.25	Oct. 7	50.50	47.53	Oct. 5	51.00	48.00	Oct. 22	49.00	44.78	Oct. 8	50.41	48.09	Oct. 7	50.01	49.64
Abu Numros	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Oct. 24	20.14	19.89

Including the year 1889 the escapes Hamad Abushushah and Galawiyah were cuts on the Nile Bank.
In 1890 the Regulators were used.
The Maâbdad Bank gauges up to 1889 inclusive are very doubful.

Table No. 3

Showing the weekly gauges during the Flood of 1890 at certain selected basin bridges in various systems in Upper and Middle-Egypt.

Table No. 3 *showing the weekly gauges during the Flood of*

NAME OF MASONRY		AUGUST									
		12			19			26			
		R. U. S.	L. D. S.	DIFF.	R. U. S.	L. D. S.	DIFF.	R. U. S.	L. D. S.	DIFF.	R. U. S.
Qinâ West	Kilh Bridge	..	..	..	82.96	82.84	0.12	83·58	83.14	0.44	83.55
	Kilh Escape	..	82.75	..	82.96	82.87	0.09	83.58	83.29	0.29	83.55
	Asfûn Head	..	..	..	79.97	79.95	0.02	80.45	80.39	0.06	80.79
	Maksar Isna	..	..	..	..	..	..	..	..	..	..
	Danfiq Escape	..	..	..	..	..	..	..	..	..	..
	Abu Shusha Escape	..	..	..	..	..	..	..	66.09	..	..
Qinâ East	Gebelâw Escape	81.96	82.20	0.24	82.94	82.91	0.03	73.62	73.36	0.26	73.92
	Ghilâsi Head	71.40	..	..	72.13	..	..	72.67	..	..	73.00
	Hamad Escape	..	..	..	68.42	..	.1	69.06	..	..	70.04
	Tarif Head	..	..	..	69.12	..	..	69.76	..	..	70.06
Girgâ East	Mazâtah	..	..	..	..	..	..	65.37	..	..	..
	Awlâd Yahyâ	..	..	..	..	..	..	64.59	64.31	0.28	65.16
	Shanshifi	..	..	..	59.47	59.46	0.01	59.84	59.63	0.21	60.16
	Harâonah	..	..	..	59.03	58.67	0.36	59.51	59.07	0.44	58.85
	Galawiyah Escape	..	..	..	58.57	57.94	0.63	59.10	58.43	0.67	59.58
Girgâ West	E. Samhûd Bridge	..	..	..	..	..	..	..	..	..	..
	W. Beni Hilâl Bridge	..	..	..	65.19	65.00	0.19	65.34	..	..	..
	E. Ya'qûb Bridge	..	..	..	62.17	..	..	64.03	..	..	..
	W. Ya'qûb	..	..	..	63.29	..	..	64.03	..	..	..
	Maqta' Magâbrah	..	..	..	..	..	..	63.20	63.18	0.02	63.45
	Awlad 'Aly	..	..	..	61.94	61.81	0.13	62.54	61.98	0.56	62.84
	Hod Suhâg Escape	..	..	..	..	..	..	..	..	..	61.69
	E. Beni Himel Bridge	..	..	..	64.70	64.72	0.02	..	..	..	65.69
	Haggi Elèw	..	..	..	63.68	..	..	63.87	63.85	0.02	64.34
	Magâbrah Village Bridge	..	..	..	..	..	..	63.66	63.65	0.01	63.83
	Birbâ Escape	..	..	..	..	..	..	..	63.88	..	..
	Awlâd She	..	..	..	62.80	62.60	0.20	62.93	62.69	0.24	62.88
	Nag. Tammâm	65.62	59.59	0.03	59.95	59.89	0.06	60.06	59.99	0.07	60.19
	W. Samârnah	..	..	..	59.20	59.19	0.01	59.24	59.21	0.03	59.67
	Banawit	..	..	..	58.23	57.44	0.79	58.28	57.79	0.49	58.42
	'Anèbis	..	..	..	57.87	57.20	0.67	57.91	57.38	0.53	57.99
	Banahû	..	..	..	58.64	58.59	0.05	58.80	58.73	0.07	58.97
	Benagâ Hod	..	..	..	57.37	57.34	0.03	57.41	57.37	0.04	57.49
	Gharizât	..	..	..	60.05	58.70	0.35	60.32	58.85	0.47	60.57
	Timâ Bridge	..	..	..	55.71	..	..	56.00	55.06	0.94	56.43
Asyut East	Nawâwrah Bridge	56.81	56.78	0.03	56.90	56.89	0.01	57.40	57.34	0.06	57.49
	Aqal Bridge	55.40	55.30	0.10	55.72	55.62	0.10	55.84	55.77	0.07	55.86
	Badâri	54.00	53.84	0.16	54.41	54.10	0.23	54.59	54.38	0.21	55.63
	Zibibah	53.04	53.10	0.06	53.68	53.15	0.53	54.44	53.85	0.59	54.71
	Matanhâ Head	52.16	51.93	0.23	52.48	52.46	0.02	53.01	52.95	0.06	53.17
	Shiu Bridge	50.29	50.25	0.04	50.51	50.33	0.18	50.75	50.50	0.25	51.53
	Sawâlim	49.31	49.00	0.31	49.63	49.38	0.25	50.55	50.05	0.50	50.96
	Matâbdah	48.53	47.28	1.25	49.45	46.99	2.46	50.15	47.06	3.09	50.11
Asyut West	She Râgib	..	..	..	..	..	..	..	..	..	..
	Beni Samit	52.30	52.27	0.03	53.49	53.27	0.22	54.02	53.87	0.85	54.97
	Shutb	51.35	51.00	0.35	52.43	51.75	0.68	53.60	52.26	1.34	54.05
	Salim	51.53	51.18	0.35	52.43	51.83	0.60	53.73	52.38	1.35	53.95
	Gebel Asyût	51.54	51.22	0.32	52.62	52.09	0.53	53.90	52.32	1.58	54.21
	Mallâh	51.85	49.18	2.67	52.10	50.53	1.57	52.29	50.73	1.56	52.34
	Misir'âwi	49.60	49.20	0.40	49.67	49.25	0.42	49.96	49.34	0.62	50.44
	Kalbi	..	..	..	48.09	47.88	0.21	48.74	48.10	0.64	49.14
	Beni Râfik	..	..	..	46.89	46.71	0.18	47.60	47.04	0.56	47.91
	Muharraq	..	..	..	..	..	..	..	..	..	47.29
	Dalgâwi	42.85	42.33	0.52	43.60	43.23	0.37	43.93	43.90	0.03	44.23
Gizah West	Mu'arqab	22.75	22.65	0.10	23.99	23.95	0.04	23.37	23.18	0.19	23.88
	Tahma	21.94	21.80	0.14	22.19	22.00	0.19	22.32	22.11	0.21	22.60
	Dahshur	20.22	19.62	0.60	..	..	..	21.00	19.93	1.07	21.44
	Saqqârah	..	..	..	..	..	..	19.10	18.85	0.25	19.97
	Shubrâment	17.55	17.00	0.55	18.30	17.30	1.00	19.00	17.35	1.65	19.33
	Minshiyah	..	..	..	16.75	16.20	0.55	16.75	16.27	0.48	17.20
	Aswad	15.43	14.60	0.83	15.49	15.08	0.41	15.88	15.66	0.22	16.16
		Dam At-Niklak									

in selected basin bridges in various systems in Upper and Middle-Egypt.

	SEPTEMBER											OCTOBER						ACCEPTED TAMAM RAYY OR FULL BASIN
9.			16			23			30			7			14			
S.	L. D. S.	DIFF.	R. U. S.	L. D. S.	DIFF.	R. U. S.	L. D. S.	DIFF.	R. U. S.	L. D. S.	DIFF.	R. U. S.	L. D. S.	DIFF.	R. U. S.	L. U. S.	DIFF.	
70	82.71	1.99	84.73	83.54	1.19	84.70	83.40	1.30	84.59	83.19	1.40	83.63	83.24	0.39	82.99	82.71	0.28	..
70	83.31	1.39	84.73	83.47	1.26	84.70	83.43	1.27	84.59	83.10	1.49	83.63	82.87	0.76	82.99	82.79	0.20	..
45	80.37	0.08	80.43	80.31	0.12	80.13	80.02	0.11	80.13	80.02	0.11	79.91	79.91	..	79.81	79.79	0.02	..
	..	..	81.39	80.84	0.55	..	..	..	..	..	..	..	..	..	..	..	..	..
73	75.25	0.48	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	75.75
	66.23	..	..	66.41	..	..	66.37	..	..	66.12	..	..	65.89	..	..	65.66	..	..
82	73.49	0.33	73.68	73.59	0. 09	73.74	73.34	0.40	73.72	72.96	0.76	73.65	72.66	0.99	73.00	72.66	0.34	73.71
75	..	..	72.75	..	..	72.67	..	..	72.30	..	..	72.64	..	..	71.98	..	..	..
71	..	..	70.38	..	..	70.19	..	..	70.32	..	..	70.31	..	..	70.18	..	..	70.60
75	..	..	69.82	..	..	69.70	..	..	69.38	..	..	69.10	..	..	68.88	..	..	..
	..	..	..	..	..	65.62	..	..	..	..	..	..	..	..	..	..	..	..
	..	..	65.41	64.54	0.87	65.02	64.45	0.57	65.12	64.11	0 01	..	..	..	..	..	..	64.96
67	60.21	0.46	..	..	..	60.77	60.13	0.64	..	..	..	..	..	..	..	..	..	..
21	59.36	0.85	59.77	58.41	1.36	59.90	58.49	1.41	60.17	58.37	1.80	59.82	59.39	0.43	..	..	..	..
21	58.67	0.54	59.36	58 76	0.60	60.04	58.79	1.25	59.15	58.57	0.58	59.16	58.44	0.67	58.36	58.38	0.02	59.59
	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	66.90
	..	..	..	..	..	..	..	..	..	..	..	65.39	65.00	0.39	..	..	..	..
18	..	..	65.16	..	..	65.25	..	..	..	..	..	64.88	..	..	..	..	..	..
20	..	..	65.13	..	..	65.33	..	..	..	..	..	..	..	..	..	..	..	..
.91	63.89	0.02	64.20	64.15	0.05	64.19	64.13	0.06	..	..	..	64.03	63.63	0.41	..	..	..	..
.48	62.14	1.34	64.00	62.34	1.44	..	..	..	..	..	..	63.51	62.37	1.14	..	..	..	..
.66	61.37	0.69	62.39	61.45	0.94	62.65	61.41	1.24	62.57	61.18	1.39	62.37	61.10	1.27	61.47	61.00	0.47	62.00
.75	65.37	0.38	65 52	65.39	0.13	65.69	..	..	..	..	..	65.17	65.07	0.10	..	..	..	65.60
.92	64.60	0.52	65.02	64.55	0.47	65.27	64.88	0.39	..	..	..	64.91	64.51	0.40	..	..	..	..
.10	64.03	1.07	64.41	64.25	0.16	64.83	64.15	0.88	64.65	64.16	0.49	64.51	64.09	0.42	..	..	..	..
.16	63.95	0.21	64.47	64.18	0.29	64.51	64.13	0.38	64.46	64.01	0.45	64.13	63.68	0.45	..	..	..	..
.98	62.76	0.22	63.46	63.23	0.20	63.61	63.40	0.21	63.71	63.28	0.43	63.68	62.99	0.69	..	..	..	..
.19	60.13	0.05	60.33	60.23	0.10	60.47	60.32	0.15	60.57	60.42	0.15	60.31	60.29	0.02	..	..	..	..
.74	59.08	0.66	59.80	59.11	0.69	59.98	59.20	0.78	60.23	59.32	0.91	60.09	59.56	0.53	..	..	..	60.35
.58	58.58	..	58.84	58.74	0.10	58.94	58.86	0.08	59.07	58.90	0.17	59.11	58.76	0.35	..	..	..	59.34
.99	58.18	0.81	58.76	57.99	0·77	58.89	57.77	1.12	58.88	57.62	1.26	58.73	57.45	1.28	58.03	57.45	0.58	58.80
.80	58.47	0.33	58 79	58.52	0.27	58.92	58.26	0.65	58.90	58.64	0.26	58.75	58.73	0·02	58.28	58.23	0.05	58.42
.25	57.62	0.63	58.26	57.65	0.61	58.17	57.61	0.56	58.18	57.55	0.63	57.46	57.45	0.01	..	..	..	58.42
.55	59.55	1.00	60.65	59.50	0 15	60.89	60.52	0.37	61.20	59.63	0.57	..	..	..	..	..	..	59.70
.10	55.61	0.49	57.05	56.40	0 65	56.72	55.96	0.76	56.48	55.87	0.61	56.17	55.67	0.50	55.59	55.46	0.13	56.90
.54	57.50	0·04	57.66	57.80	0.86	57.63	56.53	1.10	57.40	56.45	0.95	57.32	56.07	1.25	55.82	55.59	0.23	57.59
.75	53.02	0.73	56.47	25.23	0.24	56.25	56.03	0.22	56.51	55.90	0.61	55.88	55.84	0.04	55.37	55.35	0.02	56.86
.19	55.14	1.05	56.21	54.99	1·22	55.99	54.92	1.07	55.87	54.90	0.97	55.81	54.72	1.09	55.29	54.39	0.90	55.70
.11	54.25	0.86	54.99	54.47	0.52	54.90	54.37	0.53	54.92	54.10	0.82	54.68	53.99	0.69	54.35	53.93	0.42	..
.43	52.66	0.83	53.71	52.52	1.19	53.66	52.65	1.01	53.43	52.58	0.85	53.32	52.42	0.90	53.32	52.30	1.02	..
.05	50.98	1.07	52.34	51.07	1.27	52.56	51.12	1.44	52.42	50.85	1.57	52.19	50.64	1.55	51.67	50.70	0.97	51.72
.09	50.20	0.89	51.18	50.23	0.95	51.28	50.15	1.13	51.03	50.15	0.88	50.78	50.10	0.68	50.83	49.90	0.93	50.89
.31	47.11	3.20	50.34	47.50	2.84	50.23	49.35	0.87	50.34	49.46	0.88	50.25	49.40	0.86	50.06	49.29	0.77	50.00
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5.56	54.16	1.40	55.68	54.20	1.48	55.74	54.09	1.65	55.60	54.06	1.54	55.38	53.82	1.56	54.39	53.55	0.84	55.00
7.00	52.73	1.22	54.93	52.92	1.11	53.98	52.93	1.05	53.82	52.67	1·15	53.64	52.45	1.19	53.25	52.31	0.94	..
3.10	52.65	1.25	53.95	52.98	0.97	53.90	52.78	1.12	53.78	52.53	1.25	53.62	52.53	1.09	53.25	52.44	0.79	53.60
4.12	52.49	1.63	54.23	52.39	1.84	54.15	52.57	1.58	54.02	52.54	1.48	53.82	52.36	1.46	53.47	52.24	1.23	..
2.49	51.03	1.46	52.30	51 48	0.82	52.62	51.91	0.71	52.54	51.70	0.84	52.38	51.68	0.70	52.18	51.52	0.66	52.52
.71	49.41	1.30	51.31	49.75	1.56	51.87	50.01	1.86	51.66	50.33	1.33	51.58	50.31	1.27	51.19	50.18	1.01	51.05
9.37	48.35	1.02	49.52	48.92	0.60	50.38	49.13	1.25	50.48	49.60	0.88	50.52	49.48	1.04	50.40	49.38	1.02	50.06
8.36	47.96	0.40	48.88	48.33	0.55	49.16	48.18	0.98	49.51	48.46	1.05	49.51	48.48	1.03	49.41	48.56	0.85	48.51
7.96	45.41	1.55	48.23	46.04	2.19	48.24	46.37	1.77	48.15	46.47	1.68	48.45	46.54	1.91	48.46	46.49	1.97	47.35
.04	44.25	0.78	45.68	44.50	0.18	46.03	45.00	1.03	46.19	45.09	1.10	46.16	45.10	1.00	46.03	45.15	0.88	..
..	..	..	24.25	23.15	1.10	24.27	23.00	1.27	24.32	23.22	1.08	24.31	23.23	1.68	24.33	23.40	0.39	24.25
..	..	..	22.81	22.13	0.68	22.85	21.95	0.90	22.89	22.13	0.76	22.97	22.10	0.87	23.08	22.26	0.82	23.30
1.79	20.74	1.05	21.75	20.62	1.13	21.82	20.56	1.26	31.90	20.59	1.31	21.94	20.77	1.17	22.07	20.69	1.38	22.30
.83	19.35	1.48	20.65	19.56	1.09	20.61	19.63	0.98	20.65	19.68	0.97	20.78	19.65	1.13	20.80	19.80	1.00	21.00
.38	17.70	1.68	19.75	17.90	1.85	19.70	18.00	1.70	19.90	18.15	1.75	19.75	18.22	1.53	19.76	18.22	1.54	20.20
7.45	16.28	1.17	17.67	16.39	1.28	17.80	16.49	1.31	17.95	16.57	1.38	18.05	16.62	1.43	17.95	16.73	1.22	18.20
6.28	16.03	0.25	16.44	16.19	0.25	16.58	16.40	0.18	16.65	16.42	0.23	16.70	16.40	0.30	16.80	16.35	0.25	17.00

Regulation of water. — Its dangers.

8. — The Regulating bridges whether between basins to pass the water from the Upper to the Lower or to escape the water onto the Nile, are the only means by which we can hope to guard against the breaching of the basins. In consequence of the enlarging of the Canals, the water entering in even a mean Nile is far more than is required to fill the basins and thus the maintenance of Regulating Bridge becomes an object of the most vital importance to the management of basin Irrigation.

The dangers that beset the management of this class of work arise from the staff in charge. Owing to their isolated position and to the fact that the working is practically confined to only 30 days in the year, we cannot afford to maintain a trained staff on most of them and the utmost that can be done is to have a head man fairly experienced on them to regulate equally the water passing through each arch.

Erosion below Bridges - Bayyarahs.

9. — The danger of an excessive supply being let through one or two of the arches is very great and the effect most disastrous, as a hole is dug out below the bridge called the "Bayyarah" and a current is set up which eddying round, attacks the bank in which the Bridge is built and which if not checked would turn the flank of the Bridge.

Our predecessors were not fortunate in the treatment of the problem as the many ruined bridges testify. In one case, there are three bridges in ruins in the fields away from the present bank.

The problem has been attacked with varying success in the last five years.

The amount of repairs required to the badly built bridge is enormous. Thus some " Bayyarahs " have swallowed up 2000 m^3 of stone. This has been again mostly rolled into the hole downstream and another 1000 m^3 put in. These 3000 m^3 cost L.E. 1200 to L.E. 1000, and if we think of the number of similar bridges, the amount gradually swallowed up is enormous.

I do not allude to the Delta Bridges on the " Sefi " Canals in these remarks, as their supply is delivered and maintained under very different conditions.

The limits of an annual Report does not admit of a complete résumé of the conditions of this most interesting and important problem and I therefore intend publishing in a separate Report, plans of Bridges and their Bayyarahs.

Rules for regulation.

10. — But I desire to draw every Engineer's attention to the necessity of observing the following procedure.

Open the bridge gradually so that at no time may more than two planks of 25 centimetres each, be taken out of one arch in excess of the other.

Notice always if the downstream of any arch has more " boiling " of the water than others, and if so, check it as soon as possible by lowering another plank.

When the Nile has retired, lose no time in making a rough preliminary sounding by making a man walk backwards and forwards along the downstream floor to search for holes eroded in the Masonry and for 10 metres beyond the floor to see roughly where the pitching has been washed away.

Examine every groove most carefully to see if the groove stones are injured.

Major Brown on Basin Irrigation.

11. — Major Brown has written the following note on basin management. The note expresses his views on the conduct of the irrigation of the great basins of Middle-Egypt and represents an independent set of conclusions from his own experience. It is therefore extremely valuable and will assist much in stereotyping measures which have been very successful under Major Brown. The Sefi Durah is of course in Middle-Egypt irrigated from the water of the Ibrahimiyah Canal.

Necessity of early sowing of Durah crops in basins.

12. — The earliest matter calling for attention in connection with the filling of basins, is the cultivation of the " Sefi Durah " which, if in the basins, should be sown early, so as to be off the ground by the 1st August. (As a rule it is not off till the 10th August). Early sowing is beneficial or at any rate is not prejudicial to the crops and has besides this to recommend it that there is less

danger of the water supply failing before the plant has attained sufficient vigour to pass through the periods of rotation without suffering.

Maximum red water pos- ible desirable.

13. — The object to be aimed at in filling basins is to pass as much red water as possible into and through the basins. There is nothing to be gained by passing large quantities of white water through from basin to basin as it leaves no deposit, and necessitates (where sufficient regulators or Escapes do not exist) large cuts of "Takhfifs" to relieve the overfull basins, which cuts are costly to close.

ost favourable nditions for an inundation.

14. — When a basin has a direct supply of sufficient volume from the River or from a canal carrying red water, and also an escape, by which the excess water can be passed off, the basin is under the most favourable conditions for filling. If it is not so provided with a direct red water supply and escape, some arrangement should be planned, which will, as near as the particular conditions in each case admit, bring about the same results.

mmencement of filling.

15. — The basin crops of "durah" and stores of grain having been safely removed outside the limits of the basin, the red water heads should be opened as early in August as possible, so as to obtain the full benefit from the passage into and through the basins of the maximum amount of red water possible.

evel at which basin water ould be kept.

16. — As soon the basin level has risen to 25 cents below the level at which all the basin is covered "Tamam Rayy", the escape should be opened and made to discharge an equal amount to that entering the basin, so that the basin shall be kept steadily at the same level, namely 25 cents below "Tamam Rayy". Should the discharge entering by the head or heads be greater than the discharge, which the escape can, when fully open, pass out, the head or heads must be partially closed to reduce the inflow to that which the escape is able to discharge.

me for bring- g level up to amam Rayy"

17. — The above given level of 25 cents below "Tamam Rayy" should be preserved up to the 15th September: from the 15th September to the 25th September, the basins should be gradually raised to "Tamam Rayy" and not again be allowed to fall below it, till the time for final discharge has come. Those basins which will be the first to be discharged should be the first to be brought to "Tamam Rayy" the object of this rule being that each basin should reach "Tamam Rayy" 10 days before the time for its discharge so that the highest lands may receive a soaking for 10 days.

The object of not bringing the basins to "Tamam Rayy" earlier is to decrease the danger of breaches, to lessen the work of the "ghaffirs" and to diminish the erosion of banks caused by the waves, raised by a high wind in a full basin.

In Minya and Beni-Suef, where under existing circumstances (1890) the "Sarf" is about 5 days later, the dates for bringing the basins to "Tamam Rayy" might also be 5 days later. Examples :

Hod Rigga is in the condition of a basin having a head and an escape on the Nile, and is worked in the manner laid down.

When Delgawi escape is complete a thorough flow from the head at Derut and out by the escape into the Yusifi may be produced in the part of the basin lying between these 2 works.

Case of chain of basins with head entering a S. end.

18. — If there are two or more basins in a chain, with a red-water head from the Nile at the South end of the most southerly part of the chain, then *from the commencement of filling*, the regulators in the cross embankments of the first and middle basins should be left open, and those of the terminal basin only closed. In this way, more water will be drawn in through the head, while the Nile is still low, than would be the case, if the upper basin regulators were closed, since the water surface of the supply Canal will have a better slope. As the lower basins of the chain become filled, and as the Nile rises higher, the regulators of the middle and upper basins should be gradually closed, so that all the basins may fill. But if it appears, when the Nile is at its highest, that the upper basins will be short of water, then its northern regulators may be closed, its inundation completed *as far south as the level of the Nile allows*, and the water be then passed on from basin to basin to complete the inundation of the lower basins if complete. But this must not be done, where the regulator is so close to the head, that the closing of it will check the flow in and decrease the discharge of the Canal, unless there is sufficient water in the chain of basins and so situated as to ensure the inundation of all lands. Otherwise, the southern lands must be sacrificed and the bridge left open.

Instances of chains of basins under these conditions are fewer than they were before the "Sharaqi" Works were put in hand, but some are still to be found on the east of the River, in chains of basins shut off from connection with the chains above by intervening cliffs.

Chain of basins with feeder of insufficient discharge.

19. — In a chain of basins, all or some of which have red water feeders which, however, do not discharge sufficient to complete the inundation, it is important to open the red water feeders at as early a date as possible to get the full benefit from them. The filling must then be completed either from the Suhagiyah or Yusifi or from the basins on the South.

All the basins in the main chain from Asyut to Qusheshah may be considered to be more or less under these conditions at any rate during an insufficiently high Nile.

New method of filling from Yusifi.

20. — The filling of basins from the Yusifi in Asyut Province, where the Yusifi flows at a high level, is now done by observing the point where the high Flood level of the Yusifi and that of "Tamam Rayy" of the basin coincide and levelling off the banks for a considerable distance on each side of this point. The water enters freely by this opening until the basin is full, when the flow stops. If the basin becomes overfull from any other source of supply, the excess escapes into the Yusifi by this opening. The success of this method

depends a great deal on the steadiness with which the Yusifi is regulated at Derut.

As the Yusifi falls on the head being closed at Derut at time of "Sarf" these openings will discharge a great part of the water of the basins into the Yusifi and save other cuts being made.

The same arrangement cannot be applied in Minya and Beni-Suef on account of the variation in the level of the Yusifi when at full discharge and at "Sarf" level. Hence in these two provinces, it will be necessary to provide regulating heads to control the admission of water to the basins.

Admission of red water by escapes in early Flood.

21. — It is in many cases possible during the early period of filling to admit water direct from the Nile into the basins, through the works that are afterwards used to escape it. This power should always be taken advantage of, sa that red water may be introduced into the basin at as many points as possible.

Bridges Motiah, Selim and Shutb in Hod Zaunar, Qusheshah Escape (hitherto Nasri Bridge) in Hod Qusheshah, and bridge Attwab Hod Riqqa, are examples.

Discharging basins.

Sarf or discharge.

22. — The most favourable time for the actual sowing of the flooded land is from the 10th to the 30th October.

The whole of the water, except that which is required to be passed on to the basins to the north to complete their irrigation, should, if possible, be discharged either into the Nile, the Suhagiyah or the Yusifi and should not be passed on from basin to basin. By thus making the discharge on to the Nile, the Suhagiyah or the Yusifi, the water is finally got rid of out of the basin chains, and the Regulators and escapes in the more northerly basins of the chain are relieved of work and the size of these works can be diminished in consequence. Where masonry works are wanting, this system saves an excessive number of cuts, and renders cuts in "Salibahs" unnecessary except in very rare cases.

If however, in consequence of the existance of an extra liberal allowance of Regulators in the "Salibahs", cuts can be economised by passing the water on from basin to basin, the discharge should be so made. This is the case in the Beni-Suef chain of basins, where the discharge is made from basin to basin. But in this case, no other method is possible, as during the time of "Sarf" the level of the Yusifi opposite the Beni-Suef basins is so high that these basins could not discharge into it.

Main chain of Western basins.

23. — The separate sections into which the main chain of western basins have been divided, makes a more gradual and more regularly conducted "Sarf" in each section possible, independent of any irregularity that may take place in an adjacent section, and it is no longer necessary for one section to delay its discharge till the one next to it on the south is finished.

Lines of separation between section exist at: —

1) Salibah Samhud.
2) » Suhag.
3) » Zannar at Asyut.
4) The west Tarràd of Yusifi and Salibah Beni Khaled.
5) Salibah Ashmûnîn.
6) » Salaqûsi.
7) » Qusheshah.

The bridges in these salibahs (excepting 4, 5 and 6) are used for passing on water to the next section: but, if the next section requires no water they can be closed and the section of which they form the northern boundary can be discharged independently of the next section to the south.

The terminal Hods of Asyut and Minya cannot do otherwise than discharge into the Yusifi, as there is a certain length of the Yusifi unembanked between the Mudiriyahs of Asyut and Minya and between Minya and Beni-Suef, disconnecting the chains of basins from each other.

The operations of filling and emptying basins will naturally be modified by the height and duration of the flood. The following remarks relate to the Provinces of Asyut, Minya and Beni-Suef more especially and chiefly to the main western chain of basins, though the principle can be made to apply to all.

In a low Flood year, when there is an insufficiency of water, all escapes will naturally be kept as closely shut as possible, and no water which has once entered the basins be allowed to escape again before the time of discharge.

The bridges in the banks, dividing the basins into sections will be made use of to pass on water from one chain to another. If it can be so arranged (as in the Asyut to Delgawi chain and in the Minya, and again Beni-Suef chain of basins), the upper basins of each chain should before the time of "Sarf" be brought to the level of full irrigation in preference to distributing the water otherwise, so that by passing on the water from basin to basin, the inundation of each may be completed in succession. But as regards disconnected chain of basins fed from the Nile direct the limitation to filling the southerly basin must be carefully attended to.

In Minya province, under present conditions (1890), the inundation of the lands on the west of the Yusifi has always been a difficulty. Hods Bardanuha, Garnusi and Salaqusi also have given trouble, but the Abu-Baqarah Canal will improve their conditions of supply in the future.

In 1888, the basins in Minya Province were alarmingly empty at the time, when they should have been ready to discharge. To fill them and to cover the west of the Yusifi a rapid discharge of the Asyut basins along the Yusifi was made and at the same time for a period of 5 days the Ibrahimiyah, Derutiyah and Saheliyah Canals were completely closed at Derut, and the whole of the discharge coming from Asyut was given to the Yusifi. As soon as each basin in Minya become full (sufficient water having been passed on through the Salibah to complete the inundation of the basins to the north) a cut or cuts were made from it onto the Yusifi, which was thus forced up to such a level that it rose over the lands on the west of the Yusifi, entered Hod Bardanuha-Garnusi in large volume and completed the inundation of Hod Kom-es-Saâyidah.

As the Beni-Suef basins were also far from full, large openings were made in the banks at the south western corners of the basins to admit the Yusifi waters freely. In this way, all the land was inundated with the exception of an insignificantly small area.

CHAPTER II.

Nile Gauges Upper-Egypt.

Observations of Flood gauges.

24. — The observations of the Nile Flood have during 1890 been kept up and show remarkably uniform results. Some discrepancies still exist which must be watched.

The rising Flood of 1890 was so rapid that the flushes of the Nile at Wadi-Halfa or even Aswan overlapped each other. It was not really till the highest flush of the first week of September that a proper comparison could be got.

From the following table, it will be seen that the flush is very regular down the valley and that there are manifest discrepancies in the readings of Asfun, Armant, Gabalaw, Rannan, Mâannah Canal, Asyut, Kafr Ammar and El-Ayyât.

The gauges of Armant and Asyut are every fixed and the discrepancy is difficult to account for.

The Kilh Gauge has its value 0.60 lower than former years in reduced levels as the datum was altered.

List of gauge readings showing difference between highest flush of the Nile in 1889 and 1890.

DISTANCE FROM		NAME OF GAUGE	HIGHEST RISE		1890 MORE THAN 1889
RODAH	ASWAN		SEPTEMBER 1-2 1889	SEPTEMBER 2 1890	
			P K	P K	
		Aswân Cubits	**17·01**	**17·17**	..
945	0	Aswân R. L.	93.36	93.72	+ 0.36
861 1/2	83 1/2	Ramâdi Head	86.53	86.91	+ 0.38
822 1/2	122 1/2	Kilih Escape	83.56	83.71	+ 0.15
784	161	Isnâ	81.07	81.29	+ 0.22
778	167	Asfun	80.66	80.79	+ 0.13
745	200	Armant	78.51	79.14	+ 0.63
735	210	Bayyâdiyah Canal	77.91	..	..
730	215	Fadiliyah Canal	77.62	..	..
704 1/2	240 1/2	Shanhuriyah C.	75.88	..	..
663 1/2	281 1/2	Gebelaw	73.24	73.82	+ 0.58
653	292	Ghilasi C.	72.80	73.06	+ 0.26
635 1/2	309 1/2	Rannân C.	71.16	71.24	+ 0.08
613	332	Tarif C.	69.75	70.06	+ 0 31
599	346	Nag-abu-Hammâdi	68.47	68.80	+ 0.33
563	382	Abu-Shushah	66.09	66.37	+ 0.28
551 1/2	389 1/2	Baliyanâ	65.69	66.00	+ 0.31
538	407	Girgâ	64.56	64.86	+ 0.31
520	425	Minshiyah	62.83	63.11	+ 0.28
505	440	Akhmim	61.81	62.01	+ 0.20
498	447	Suhâg River	61.33	61.55	+ 0.22
482	463	Shandawil	60.13	60.37	+ 0.24
468	477	Galawiyah Escape	..	58.42	..
454	491	Nawâwrah Syp	57.32	57.56	+ 0.24
405	540	Maannah C.	52.93	53.43	+ 0.50
395	550	Asyût Ibr. C.	51.86	52.45	+ 0.59
285	660	Rodah (Asyut)	42.45	42.76	+ 0.31
245	700	Minyâ	39.08	39.50	+ 0.42
176	769	Maghâghah	33.72	34.12	+ 0.40
139	806	Biba	..	30.57	..
120	825	Beni Suêf	..	28.88	..
85	860	Wastah	25.68	26.00	+ 0.32
64	881	Kafr Ammâr	23.45	24.20	+ 0.77 •
50	895	El-Ayyât	22.28	23.11	+ 0.83 •
24	921	Berishên	20.30	20.50	+ 0.20
4	941	Rodah (Cairo) { cubits	22.04	22.21	..
		{ metres	19.06	19.44	+ 0.38

• Probably 0.35 too much owing to change of value of datum bench mark.

CHAPTER III.

Sefi or Summer Irrigation 1890.

State of Summer supply in 1890.

25. — The Nile in 1890, though not quite so low as in 1889, was very low indeed as it sank to 10 kirats at Aswan on 28th May and remained below 1 cubit from 24th April to 15th June.

The following table shows the dates of falling below one cubit and rising again above it at Aswân for the last 21 years.

YEARS	MINIMUM GAUGE				DATE OF DROP BELOW ONE CUBIT	DATE OF RISE ABOVE ONE CUBIT	BELOW ONE CUBIT N° OF DAYS
	DATE	CUBITS	KIRATS	REDUCED SEA LEVEL			
1870	15th June.......	0	15	85.50	20th May.......	24th May.......	3
1871	16th May.......	1	13	84.99	Nil	Nil	»
1872	24th »	1	0	84.70	24th May.......	26th May.......	1
1873	3rd June.......	0	21	84.63	20th »	6th June.......	16
1874	29th May.......	0	8	84.34	11th April.......	2nd »	51
1875	23rd »	1	21	85.17	Nil	Nil	..
1876	9th June.......	1	19	85.13	Nil	Nil	..
1877	26th May.......	1	18	85.10	Nil	Nil	..
1878	7th June.......	0	6	84.29	22nd April.......	26th June.......	64
1879	23rd May.......	5	1	86.88	Nil	Nil	..
1880	3rd June.......	3	2	85.82	Nil	Nil	..
1881	10th June.......	1	16	85.06	Nil	Nil	..
1882	21st »	0	13	84.45	11th May.......	25th June.......	44
1883	21st »	1	15	85.04	Nil	Nil	..
1884	26th May.......	2	6	85.37	Nil	Nil	..
1885	21st June.......	0	18	84.56	25th May.......	2nd June.......	29
1886	3rd June.......	1	11	84.95	Nil	Nil	..
1887	5th May.......	1	12	84·97	Nil	Nil	..
1888	5th June.......	1	10	84.92	Nil	Nil	..
1889	4th »	0	11	84.40	13th April.......	27th June.......	74
1890	28th May.......	0	10	84.38	24th »	15th »	52

Mean gauges of the Delta.

26. — The following are the mean gauges of the Delta supply for the years 1887-1890.

MONTH	YEAR	SHUBRAH GAUGE	UPSTREAM ROSETTA BARRAGE GAUGE	DOWNSTREAM DAMIETTA BARRAGE GAUGE	DOWNSTREAM RAYYAH MENUFIAH GAUGE	DOWNSTREAM RAYYAH TAUFIKI GAUGE	MANSURAH GAUGE	ASWAN GAUGE		REMARKS
								CUBITS	KIRATS	
January............	1887	14.30	13.23	13.25	13.61	..	2.87	5	18	
	1888	14.50	13.48	13.30	12.90	..	2.93	6	03	
	1889	13.60	13.00	12.86	12.87	..	2.65	4	00	
	1890	13.89	13.05	12.70	12.26	..	..	5	05	
February..........	1887	13.80	13.10	13.10	11.47	..	2.76	4	09	
	1888	13.70	13.00	12.70	12.83	..	2.20	4	10	
	1889	13.32	13.00	12.60	12.88	..	2.27	2	10	
	1890	13.58	13.05	11.97	12.68	13.05	..	3	12	
March............	1887	13.70	13.22	13.10	12.90	..	2.60	2	22	
	1888	13.50	13.05	12.50	12.93	..	1.89	3	02	
	1889	13.20	13.00	11.80	12.84	..	1.30	1	12	
	1890	13.41	13.17	11.95	13.01	13.16	1.80	2	02	
April..............	1887	13.10	12.76	12.45	12.14	..	2.10	1	19	
	1888	13.30	13.01	12.24	12.90	..	1.54	2	05	
	1889	13.19	13.00	11.40	12.84	..	0.60	1	00	
	1890	13.37	13.13	11.06	12.97	13.13	1.08	0	20	
May..............	1887	13.08	12.84	12.10	12.66	..	1.60	1	19	
	1888	13.28	13.03	11.90	12.86	..	1.20	1	18	
	1889	13.16	13.00	11.10	12.84	..	0.19	0	14	
	1890	13.35	13.07	10.43	12.91	13.00	0.17	0	14	
June..............	1887	13.16	12.95	12.15	12.74	..	1.70	2	22	
	1888	13.20	12.96	11.50	12.80	..	0.78	1	20	
	1889	13.08	12.90	10.80	12.75	..	0.25	0	14	
	1890	13.13	12.74	10.49	12.78	12.90	0.16	1	07	
July	1887	13.50	13.26	..	13.05	..	1.24	7	16	
	1888	13.28	13.05	..	12.88	..	0.83	4	15	
	1889	13.02	13.08	..	12.90	..	0.38	3	14	
	1890	13.35	13.60	11.43	13.41	13.51	0.12	5	23	
		*					**			

* Opened Barrage, 2nd July 1887. Average up to 20th July at Shubra.
» » 31st » 1888. » » 20th » »
» » 29th » 1889. » » 9th » »
» » 28th » 1890. » » 7th » »

** The July Mansourah gauges are for the first ten days of the month.

The Downstream Damietta Barrage no longer represents the water passing down for the Irrigation of the eastern provinces, but is given to show how tight the closure of the Barrage was.

The comparison of the Mansurah gauge with the former years is interesting as it shows the water escaping to the sea. The June gauge shows that there was very little difference. That means that the gates of the Damietta Barrage were stanch and that the engines on the Banks utilized practically all the percolation water.

Discharge of Nile at Cairo.

27. — The discharges of the River at Cairo can only be deduced from the sum of the discharges of the Canals taking off below Cairo.

The water at Cairo in low Niles is practically a still water pond.

Mr. Roux, attached to the 2nd Circle, took the following discharges on 16th and 17th June. On these days, the gauge readings were:

		JUNE 16	JUNE 17
Rodah Cairo		8.02	8.03
Shubrah		13.07	13.07
Barrage gauges	Upstream Rosetta Branch	12.85	12.85
	Downstream Damietta Branch	10.08	10.08
	Downstream Rayyah Taufiki	12.84	12.84
	Downstream Rayyah Menufiyah	12.72	12.72
	Downstream Rayyah Beherah	12.82	12.82
	Downstream Rosetta Branch	10.00	9.99

The discharges were:

1st Circle above Cairo	Ismailiyah Canal	2,530,000	
	Sharkawiyah Canal	920,000	
	Basusiyah Canal	250,000	
		3,700,000	9,100,000
Rayyah	Taufiki	5,400,000	
	Menufiyah	8,100,000	
	Behera	2,500,000	
		1,9700,000	
	Leakage at Barrage (say)	300,000	
		2,0000,000	m³per diem.

Fortnightly discharge 1st Circle.

28. — Mr. Garstin has had his Canal discharges taken during the year every fortnight and the following table shows the dimi-

nution of supply and the slow rise of the supply owing to the rising Nile.

It must be understood that there is generally no pressure before May 1st.

Discharges in Cubic Metres per Diem.

Date		Ismailiyah	Sharkawiyah	Basusiyah	Rayyah Taufik
May....	1st.......	2,993,760	876,096	390,528	6,148,207
	15th......	2,828,571	925,520	387,072	5,511,331
June ...	1st.......	2,575,540	924,480	439,776	5,717,182
	15th......	2,566,961	787,104	261,792	5,319,863
July....	1st	3,223,929	897,696	368,364	6,039,342
	15th......	4,397,621	1,600,128	939,162	8,520,313
August.	1st	5,296,233	1,884,384	996,192	7,540,841
	15th......	....	7,586,784	6,715,872	19,068,480

August 15th Discharge was not taken for the Ismailiyah Canal owing to the closure of the Locks.

The August 15th Discharge of the Rayyah Taufiki was due to the gauge of 15.00 at its head. The discharge was checked by Mr. Liernur on September 29th with the downstream gauge = 15.02 and found to be 18,812,448 M^3 per diem.

istribution of water.

29. — The distribution of the water was enforced by the most praise worthy exertion of all the staff. The Mudirs and their subordinate staff gave great assistance and it may be safely said that without the help of the civil officers, irrigation in summer with a short supply of water would be impossible.

The combination of Mudir and Inspector has had the very best results, and the Ministry of the Interior were ever ready to check any indifference on the part of the Provincial authorities.

ate of Crops.

30. — The area of crop matured of all kinds was very large and fortunately the cotton worm was not so prevalent as usual.

The result has been a very large increase of cotton : 4,100,000 kantars against 3,200,000 of the year before.

Sadds or Dams at the mouths of the Nile.

31. — The Rosetta Branch Dam at the mouth of the Nile was maintained with great success by the 3rd Circle and rendered it possible te use the Atfeh pumps. The Dam at the mouth of the Damietta Branch was however abandoned after mature consideration as being injurious to the flow of the Branch in flood. The Rayyah Taufiki on the right and the Bahr Shibin on the right with their riverain Branches supplied the water fresh and wholesome, though not in so great abundance as could be wished. The difficulties of disconnecting the Nile Bank engines from their intakes on the River was met by cutting channels to their intakes from the riverain Canal. The Government warned the Land owners in February that there would not be sufficient water for rice and that the river would be salt. They disregarded the warning and did not make the necessary connections. The result was a loss of crop from salt water.

I am most certainly of opinion that this dam should not be permitted in future, as its yearly renewal will seriously disturb the regimen of the lower reaches of the Damietta Branch.

The following notes are from the reports of the Inspectors showing in each Circle the most note worthy points.

Sefi 1st Circle.

Effects of the new Rayyah Taufiqi.

32. — The first Circle was completely revolutionized by the opening of the Râyyah Taufiki, the new canal taking off from above the Barrage and feeding the Bahr Mues, Sâhil Canal, Um-Salamah Canal, Mansûrîyah Canal, and the Sharkâwîyah-Fâraskûr. This fine canal now supplies all the northern part of the Province of Sharkiyah and all the province of Dakahliyah.

State of minor distribution Canals.

33. — The difficulties of distributing water along the long-line of 175 kilometres of main Canal were much aggravated by the

very inefficient state of the minor Canals taking from it. So much money has been spent in making the Rayyah Taufiki itself that the Public Works Ministry found it impossible in the interest of other Circles to allot further sums for internal distribution and the result was an excess of water in some parts of the system and great drought in others. A beginning was made in great haste by making new or repairing old heads of branch Canals in the main line, but this was not enough. The entire system has far too many Canals of distribution. They are all dug down to an abnormally low level, in order to get a little summer water in each on the old system and when the Rayyah Taufiki filled the old trunk Canals to a depth of 2 metres more than before it was almost impossible to check the out flow of water through the new heads. It thus came about that the lower parts of the system were almost in the same state as before, the water not being raised practically.

Cessation of irrigation from River.

34. — The water also in the lower reaches of the Damietta Branch being salt owing to the earthen dam (sadd) not having been made below Damietta, was not available for irrigation and consequently the Trunk Canal parallel to the River had to irrigate much Land usually irrigated direct from the river.

Regulation in Sharkiyah.

35. — The water delivered into the Bahr Mues was most easily regulated at Zagazig where the large nine arched regulator across the Bahr Mues and the head of the Bahnabai and Mashtûl distributary Canals had been fitted with horizontal regulation over raised cills. The water, though raised up to nearly Nile level, was thoroughly under control. The following is extracted from Mr. Garstin's report. The difficulties and their remedy are suggested by his practical experience of the district.

Mr. Garstin on difficulties of distribution Dakahliyah.

36. — It will be seen on comparing this table of discharges with that given in Report for 1889, that the supply throughout the year in 1st Circle was decidedly better in 1890 than in 1889. At the same time the difficulties of water distribution were enormously greater in 1890 than in 1889.

This was caused by the fact that though the total supply for the three provinces was better than in 1889, yet it was not divided so well between them, and though the provinces of Sharkia and Kaliubia were much better off than they had been for the three previous years, the province of Dakahlia was decidedly worse off.

The reasons for this were briefly :

1st. The Rayah Tawfiki caused sudden changes in the distribution of the water in Dakahlia province; it was like a tight machine and the first year did not work as smoothly as it will in future.

2nd. The Sahel Canal not having been widened kept the water level up higher than we wanted and with the very least opening of the new Heads taking from it "Birrahah" irrigation, was available on all its branch Canals. Markaz Mit Ghamr had free flow water throughout the summer.

3rd. No gain at all was experienced in level in the Mansuria Canal owing to the fall into it from the Sahel: This will not come right until the bed slope in readjusted.

4th. Instead of having four heads all taking from the River direct, such as Bahr Muès, the Sahel, the Um Salama and the Mansuria, they all now take from one Canal: Before they each used independently to feel the benefit of any rise on the two stone "Sadds" and gained in supply in proportion.

5th. The Sharkawia-Faraskur Canal gave free flow water throughout a great portion of its length and consequently it was exceedingly difficult to force the water down to Damietta, where in consequence of the failure of the Damietta cistern, it was obligatory to keep up a constant supply for drinking purposes.

6th. The great length of the one line i.e. 178 kilometres from Benha to Damietta and the consequent difficulty of enforcing the Manawbahs.

The above are the chief causes of the difficulties in Dakahlia Province in 1890. At the same time owing to shortness of funds I did not clear more than two thirds of the "Sefi" Canals: This naturally caused more difficulty.

Possible Remedies.

37. — All the foregoing are remediable and I hope 1891 will see a great difference :

No. 1. Will remedy itself.

No. 2. We are now widening the Sahel and in the summer I shall put a special Engineer with patrols to close all the sahel Heads through the Manawbas and with earthen dams if necessary.

No. 3. I think a Lock and Regulator at Sansat in the Mansuria and another at Brimbàl Gadim in the Bahr Saghir are indispensable.

No. 4. We cannot alter.

No. 5. The widening of the Sharkawia Faraskur should be completed and I hope the cistern at Damietta will be repaired next year.

No. 6. The clearances this year will be worked out in Dakahlia on their old bed levels, not as last year on a higher level as calculated for the Rayah Tawfiki.

In addition to the above, repairs to the old regulators and several new regulators are required in all the Buhia and Sahel branch Canals to enable us to better control the water once it leaves the Canal heads; I also think it will some day be necessary to widen the Buhia itself.

Principal places of difficult distribution.

38. — The following were the places where the difficulty was chiefly felt in Dakahlia Province in 1890.

1) *Markaz Miniet Samânûd.*

The tract lying between the Buhia and Um Salama Canals and the Railway from Mansura to Simbellawin.

2) *Markaz Simbellawin.*

On tail of Buhia itself and the Abul Qaramil estate.

3) *Markaz Mansura.*

The last ten kilometres of Iràd and Gabàda Canals.

4) *Markaz Faraskur.*

The tail of Ezbet El Burg Canal.

5) *Markaz Dikirnis.*

The "Aqlîm" El Manzalah and Beni Abed and Mit Sued at the tail of Bahr Tanah.

6) *Markaz Mit Ghamr*

The tract where the Branch Canals from Buhia and Sahel Canals intersect one another and from there right up to Bahr Saft at Dîarb En Nigm. This is partly in Simbellawin and partly in Mit Ghamr Markaz.

The above parts all suffered severely during June and the first half of July.

Proposed Works.

39. — To remedy No. 1 we want a new head for Um Salama, and I think (possibly) a new regulator in Buhia below the head of Urmàn Canal.

To remedy No. 2 we require to widen the Buhia Canal and repair the old regulator north of Simbellawin.

To remedy No. 3 as regards Gabada Canal the new Um Salama head will I hope put things right as it was the difficulty of regulating on the stone dam at head that caused the loss of water last summer. As regards the Iràd Canal, the water was there, but as the Daira Sanieh had no "sakias" or means of raising water upon it they could not use it. I have written to them to say that unless they make "sakias" or some arrangement for raising water next year, I shall stop the water above the tail, as it all goes to waste at present. The same remark applies to the Beni Abed Estate about which I spoke to Abdul Kadir Pasha and Ibrahim Pasha Tewfiki the other day: they have no machines for raising water and trust entirely to "free flow" which they cannot always get.

To remedy No. 4 we are going to widen the Sharkawïa Faraskur Canal from Zarga to Sharabas and also straighten the head piece of Ezbet El Borg Canal commencing in 1891.

To remedy No. 5 we are going to dredge the tail of Bahr Saghir from Gamalia downwards commencing in 1891.

To remedy No. 6 we have alloted L.E. 2000 in Budget of 1891 for remodelling the Regulator in this tract.

I think it will be better to lower the crest of the stone dam below the Mit Ghamr Regulator. This was built at R.L. 7.00 at first, but afterwards lowered to 6.70: it was calculated from the formula for submerged weirs to throw a certain back-water on the Mit Ghamr regulator: at the same time with difficulties in supply it will I think be wiser to lower it to R.L. 6.00 which will be 0.50 above R.L. of regulator floor and 1.00 above floor of lock.

Minor improvements.

40. — Other minor improvement necessary are:

A) Making a regulator in Saffuria Canal (taking from Buhia) below the take off of Sultani Canal.

B) Straightening the Um Yunis Canal from Bahr Saft.

C) Widening and embanking the Bahr Derham from its end at Barmakim to the end of Um Yunis and putting a regulator on its tail.

D) Widening the section of Dakhakhni Canal from Barmakin to Dibigia.

E) Two small Canals for the loops of Sharabas and Kafr El Mayasra both taking from Sharkawia Faraskur Canal. These are necessary as the distance to the Nile Bank is so great in each of these loops.

In the above extract, I think Mr. Garstin dwells too much on the difficulties of rotation by closure of heads and does not take sufficiently into account the great increase of cotton in the districts irrigated by the Rayyah Taufiki. Matters will right themselves as the working gets more into order, but a certain amount of money must be spent in changing canal alignments and in grouping canals.

Supply in Kaliubiyah.

41. — In Kaliubiyah, the supply was as usual extremely short and the people did their best to utilize it. We cannot afford to dig more "Sefi" canals in Kaliubiyah as there is no outlet for the Flood water which must be introduced into these "Sefi" canals. It may be found possible to dig canals for summer only. The cost will be very great as the canal, to carry any fair supply of water, must be 8 metres bed and 5 metres below soil and would cost L.E. 1,000 a kilometre for earthwork and L.E. 600 for land. Its length would be 30 kilometres and if we allow L.E. 5,000 for masonry works, a sum of L.E. 53,000 would be required, and after spending this, the cultivators would have to provide themselves with engines to lift the water.

The very greatest pressure is being brought on us to dig this canal, but without aid of a loan it is quite impossible to get this large sum from the Public Works Budget.

Rotations.

42. — Rotations to distribute the water were in force as follows:

MUDIRIYAHS	STOPPAGE OF ENGINES	STOPPAGE OF SAKIYAHS	STOPPAGE OF CANALS
Kaliubiyah ..	12th June — 16th July	Nil	7th June — 16th July
Sharkiyah...	18th » — 27th »	23rd July — 27th July (locally)	23rd » — 27th »
Dakahliyah..	10th » — 4th August	5th July — 22nd July	10th » — 28th »

These dates mean that in the period indicated the rotation periods of flow and closure were observed. Before and after these periods, water was freely taken by everybody.

The Mudir of Kaliubiyah and the Chief Engineer worked very hard indeed, both being frequently out for days patrolling and keeping their subordinates up to the mark.

Sefi 2nd Circle.

Supply.

43. — In the 2nd Circle which comprises the country lying between the two branches of the Nile, the water supply was very short owing to the low supply in the River and owing to the abolition of the earthen dam in the Damietta mouth of the Nile. Much of the area irrigated by engines from the Nile direct was supplied by the riverain Canals taking from the Bahr Shebin. Thus the water entering the head of the province had to do more duty than last year. Mr. Willcocks introduced several internal changes which were productive of much benefit.

Changes in supply of Canals.

44. — They are the following, extracted from his report:

The tail of the Kasid Canal which was always in difficulties was supplemented by the new Safti Canal, 20 kilometres in length, taking out of the Baguriyah Canal.

The Nanaiyah and Sirsawiyah Canal which failed completely in 1889 were supplemented by the Bahr Faraoniyah and proved successes. The Bahr Faraoniyah was opened from Rayyah Menufiyah with signal advantages both to navigation and irrigation. The Mudir of Menufiyah, Nashaat Pasha, threw himself heartily into this work and collected the necessary funds from the interested parties.

The Bahr Sêf, another feeble canal, was supplemented from the Batunaniyah Canal, and did its irrigation without a single complaint for the first time in its history I think. Here again the Mudir, Nashaat Pasha, was invaluable. As to the Irrigation on the two Nile branches near the Sea, it is my opinion that the Rosetta "sadd" should always be put in, as the Rosetta Branch is deepening and scouring its bed and no fears need be entertained for it. The time to do away with this "sadd" will come when the proposed reservoirs in the "Birriyah"* are a success, if they ever are a success. The Damietta branch on the other hand, should never be dammed at its mouth, except under exceptional circumstances, as the Damietta branch is dying away and dying fast. Any interference with its bed is to be deprecated. I hope that the "Birriyah" reservoirs will prove a great success and do away with the exceptional occasions on which the "sadd" should be made. In April and May, before the regular summer Irrigation begins, every available drop of water should be sent down the Damietta Branch.

Engines on Nile.

45. — On the Damietta Branch, the engines north of Sherbin are of 526 HP. capable of lifting 263,000 cubic metres per 24 hours when working by day, and 526,000 cubic metres per 24 hours when working night and day. The tax paying area is 25,000 Feddans which requires 500,000 cubic metres per day, as $^{2}/_{3}{}^{d}$ the area should be put under "Sefi" on the Rosetta Branch there are engines of 416 HP. and 133 HP. of "Sakiyahs", making a total of 549 HP., and 3 Canals of a total length of 22 kilometres. The total area commanded by the Nile is 30,000 feddans requiring 600,000 cubic metres per day or $^{2}/_{3}{}^{d}$ the area should be cultivated "Sefi".

These figures of Mr. Willcocks must be taken as an expression of his opinion. The land, except on a narrow strip near the Nile, is very poor and will not stand for long the exhaustive cropping indicated by him.

The inhabitants have fresh water in the Nile practically from July 15th to May 1st and although rice is not possible over large areas, the cotton plant, requiring so little water in the damp sea air, will give a good return if sown in moderation.

Rotation.

46. — The distribution of water by rotation on the ten days shift has become permanently fixed in this Circle on a ten days shift, i. e. the Canals and Engines running 10 days and leaving

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* The Birriyah is the low land on the edge of the lakes in the north of the Delta.

off for ten days. The discharge entering the Rayyah Menufiyah does not vary much between March and Mid Summer. The excessive demand which springs up in June and July is principally caused by the great heat and by the commencement of the Maize crop.

Sefi 3rd Circle.

Supply from Pumps & Rayyah Beherah.

47. — The supply of the Province in March was maintained at a high figure by the Khalatbah pumps aided by the Atfeh Pumps.

On April 1st, the Rayyah Beherah which had been kept shut to allow the dredgers to finish their work, was opened, and by the 11th April, the Khatatbah pumps were finally stopped. The Rayyah gave 2,700,000 m^3 per diem. It was so well cleared that even with the Barrage at 12.90 the supply at Khalatbah, after passing through all the sand, etc., was $2\,{}^1/_2$ millions. The Rayyah Behera and Mahmudiyah discharges are as follows for the season: —

DATE		DISCHARGE AT THE HEAD OF THE RAYYAH BEHERA		DISCHARGE PUMPED INTO THE MAHMOUDIYAH AT ATFAH
		GAUGE	DISCHARGE	
March	1st	...	...	2,000,000
	18th	...	...	1,500,000
	26th	...	...	2,000,000
April..	16th	13.66	2,678,000	...
	25th	13.63	2,709,000	2,500,000 (This discharge of $2\,{}^1/_2$ millions continued till 10th August when the pumps stopped working).
May...	17th	13.61	2,667,000	
	31st	13.49	2,660,000	
June..	17th	13.43	2,455,000	
July...	8th	14.02	3,896,000	
	15th	14.45	4,806,000	

The increase of supply as seen in this table is very marked. On the 17th of June, the discharge was about 5 millions altogether.

On the 8th July, the discharge had risen to 6,396,000 m³ and on the 19th July it was 7,306,000 m³.

Increased supply to Province.

48. — The immediate result of this was that the "dura" (maize) was put in easily in July before the Flood rose, and thus for the first time, Beherah has had a chance of getting as good a crop as the other Delta provinces. Formerly when the supply was wholly derived from pumps, there was no increase possible until the Nile had drowned the pumps, i.e. until about August 10th.

Flooding of Lake Mareotis.

49. — The immediate result of this increased ease of early flood water has been to flood Lake Mareotis, as in September, after the cotton and "dura" (maize) had grown, there was not much demand for water. In the other Delta Provinces, the surplus water of September and October escapes into the Lakes which have an outlet into the sea. In Behera, the Lake Mareotis is at flood 2.4 metres below sea level and thus this Lake cannot be used freely like the other lakes as an escape. The only remedies are:

1) Very careful distribution of the water.
2) Pumping from Lake Mareotis into the Sea.

The first remedy points to closure times in the Nile season — a new and disturbing thing to Egyptian cultivators. If we close a Canal wholly one week and run it full another week, the "dura" and cotton will be well watered and the Canal will not discharge large quantities of water into the low lands at its end.

Rotations.

50. — Mr. Foster reports that the Beherah landlords and cultivators are well satisfied with the rotation for cotton on the Khatatbah system. The period is 8 days run and 8 days closure.

But on the Mahmudiyah Canal, there is, I fear, always be discontent. M. Foster writes :

Mr. Foster on Mahmudiyah rotations.

51. — In 1889, the rotation periods on the Mahmudiyah were 5 days, but as I said in my Report for that year, these long periods undoubtedly killed the rice. I wanted to have 4 days rotations, but the opposition was very strong, and eventually a compromise of 3 days was decided on. The following is the arrangement agreed to by the *sheiks* and *omdehs*.

SECTION	POSITION		DAYS	CLOSED	OPEN
	FROM	TO			
I.	Atfeh	Kafr-Dawar	3	All branches and Pumps on section II.	All branches and Pumps on section II.
II.	Kafr-Dawar	Gabari on south and Hagar Nawatiya.	3	All branches except Rosetta and Mehallet Keil and all steam pumps on section I.	All branches and Pumps on section I.

The above system of rotations was started on the 23rd May, but owing to the very extensive area cultivated and the absence of any means for limiting the quantity of water taken into most of the private canals, it was found that the Mahmudiyah was gradually being drained. The Alexandria gauge fell so low that energetic measures were necessary. Consequently the rotations were altered on the 21st June by having one day in seven an absolute closure throughout the whole length of the Canal. By this means, the water supply in Alexandria was maintained at a fairly high level.

Again on the 18th July, the rotation system was modified. It was found that water did not reach the end of most of the larger branch Canals during the three days of supply. The Chief Engineer and Mudir together put rotations on these branches giving each 36 hours water, that is to say that surply was to non supply as 3 to 14 less than 1/4. I knew this would not do. Complaints came crowding in that, it was impossible to irrigate in so short a time; consequently I decided to remove all the larger Canals from the original rotation and allow them to flow 6 days out of 7 and to put rotations on the Canals themselves. By this means, every one, both on the Mahmudiyah and on public and private branches received 3 days water out of 7.

It is impossible to manage rotations on a multitude of small Canals. That rotations were necessary on them shows that either their section is too small or that cultivation is excessive. I believe it is due to both, though there is not the least doubt that the cultivated area is far in excess of the proverbial one third. The size of all the branches of the Mahmudiah must be increased by degrees. They are as a rule wretched things, more like ditches than Canals. They were originally made for small areas close to the Mahmudiyah, they have gradually been lengthened as new land has been reclaimed, but the original section has not been much increased. As in some cases, the area to be irrigated has more than doubled since the canal was made, it is not surprising that water will not reach the new or lower lands.

These Mahmudiyah rotations gave an immense deal of trouble. There were three engineers always on the Canal, and I went there several times. Yet the result was most unsatisfactory. It is true the crop has been a very good one and upward of 25,000 feddans of rice have been matured and with success; but the labour and continual worry involved is beyond endurance.

Private Canals if they have masonry sluices as a rule have no regulating shutters. During non supply periods, such sluices are closed with little earthen dams which constantly breach, and to decide whether the breaching of them has been due to accident, or done purposely is impossible. The floors of sluices are very low, consequently they not only take water when they ought not, but take too much. The improving of the state of affairs forms the subject of a special report.

With screw shutters and raised cills, Canals flowing by gravitation will be properly regulated.

If possible, rotations should not be put on rice Canals before the 1st June. Planting is carried on until the 20th May. The first few days, rice is above ground, it is very delicate and easily destroyed by drought and heat, consequently rotations are feared

There were, as usual, many complaints from the Mehallet-Keil. In May, I called a meeting of all landowners and after studying the areas to be irrigated, fixed on a system of rotation somewhat different to that of last year. It was fairly successful; but one landowner is very much agrieved, because he does not get a large supply of water for his land which is the same height as that bordering the Mahmudiyah 15 kilometres off. It will be noticed that the periods of rotations were 6 days. Notwithstanding this, a large area of rice was grown and lived. On one estate of 1000 feddans, 950 feddans were under crop at the same time. The owners of land on this Canal and branches are the most unruly in the province.

Cost of pumping.

52. — The following table shows the cost of pumping water for the past 6 years.

1885..................	L.E.	30,636
1886..................	»	51,287
1887..................	»	53,851
1888..................	»	61,255
1889..................	»	59,999
1890..................	»	49,822

Sefi 4th Circle on Ibrahimiyah Canal with the Fayum.

Ibrahimiyah Canal. Early sowing of cotton.

53. — Major Brown reports that the sugar cane was planted and the cotton sown nearly a month earlier than usual. The Dairah Saniah set the example and it was very generally followed. The result is that the first watering after germination was given in most places before the rotation distribution had to be employed. This is a most important point to be insisted on as the preparation of the ground for watering and the first watering of the crop take much more water than the second watering after germination.

The rotation of water distribution commenced and ended as follows: —

PROVINCE	DATE ON WHICH ROTATIONS WERE BEGUN	DATE ON WHICH ROTATIONS WERE STOPPED FINALLY
Asyut..................................	11th May	27th June
Minya..................................	20th March	17th July
Beni-Suef..................................	1st May	17th »
Fayum..................................	1st May	21st »

The length of "Close time" was in Minya from 4th May to 3rd July in accordance with the complete programme which gives a watering to each field once in 21 days, that is, there are 14 days close time on a distributary Canal during which the Canal is not running and 7 days in which it is running and distributing its water in internal rotations along its length.

From 10th June to 3rd July, the limit of 21 days was further lengthened to 24.

The methods employed in Asyut, Minieh and Beni-Suef were practically the same as in 1889.

Major Brown on the new system of rotation in Fayum.

54. — The system elaborated in the Fayum was a new one. Major Brown called a meeting of the principal landowners (omdehs) and laid before them a proposal without insisting on it. I extract the following verbatim from his report as it shows how what good results follow from taking the cultivators representatives into consultation with the Government officials. If the irrigation officer forces on the people an arrangement of a most scientific type, they will not lend any aid towards carrying it out, whereas, if in consultation between him and the people, he gives in a little and adopts a less scientific arrangement, they themselves will naturally give more aid in carrying out the method, elaborated in consultation with them.

Major Brown writes: —

The programme proposed by me was to give all the Canals in each "Markaz" successively water for approximately one third of the full period of rotation. Thus, if it was decided to give one watering in 15 days, each "Markaz" would in succession have had water for 5 days (or for the number of days proportional to its area with reference to the total area of the Province) and have been without water for ten days. The advantages of this programme were that the rotation could have been simply effected by closing the Yusifi heads of those Canals, which were to be kept without water, and further that the whole force of Engineers and Supervising Staff could give their attention to one "Markaz" at a time under the eye of the Chief Engineer. But I was not sufficiently acquainted with the Province to feel confident that such a programme would not raise difficulties concerning drinking water for men and beasts, seeing that all the Canals in each "Markaz" would be kept without water for 10 days at a time in succession.

The Council of Omdehs considered this objection insurmountable, and proposed dividing each Canal into three sections, and giving water to each section in succession. As this proposal seemed to commend itself generally to the assembled Notables, I agreed to accept it as a basis for working out a programme. The next point, which they were consulted about, was what should be the full period of rotation, or number of days in which one watering should be given. The Council decided that it should be once in 12 days and would not be persuaded that this allowed for too frequent waterings, but declared that they would sooner provide for giving a watering once every 12 days to an area, say of 2.000 Feddans of crops, than increase the Crop area to 3.000 Feddans and allow watering once every 18 days only. This I also accepted as a basis, though I considered the duration of one full period of rotation should have been *at least* 15 days.

The programme adopted was as follows:

The Canals, having their heads on the Bahr Yusif, were divided into three classes, viz:

Class 1. Large Canals, commanding areas of 10.000 fedeans, or more.
Class 2. Medium Canals, commanding areas from 10,000 to 2,500 feddans.
Class 3. Small Canals, commanding areas less than 2,500 feddans.

The Canals of Class 1, commanded in the aggregate 217,181 feddans out of the total area of 277,144 feddans. Each Canal was divided into 3 sections and each section was given water in turn for a portion of the period of 12 days proportional to the area commanded by it.

The Canals of Class 2, commanding 44,303 feddans, were each divided into two sections and each section in turn given water for a period of the 12 days proportional to the area commanded.

The small Canals of Class 3, were divided into two groups and each group alternatively received water for six days, and was deprived of it for the next 6.

The discharge of the Yusifi was divided among all the Canals in proportion to the area of each Canal, the two groups of Class 3 receiving double supply for half time alternately.

Early in the year I had, on every opportunity, discussed the question of the distribution of water with different land owners and others in the Fayûm, and found that they agreed entirely with me that the distribution should be proportional to the area commanded (Zimâm) on each Canal, and not to the area, which might be declared to be planted, as it is impossible to arrive, even approximately, at the planted areas, and it was further not just that, because an excessive area was planted in any one village, other villages should have their proportional share of water diminished in consequence. Finding the Province with me in this opinion, I ordered the Chief Engineer to make out a complete list of all the areas commanded on each branch of the canals. With the ready help of the Mudir and a succession of sheikhs, and naturally much of councils talk and discussion, the Chief Engineer completed a list which was accepted and sealed by all the sheikhs. This involved no small amount of labour on the part of the Chief Engineer and the successful completion of the accepted list was a great advantage gained. The distribution of water being subsequently made in the proportion of the areas on this list was accepted as just by all, and not a single complaint against the fairness of the Programme drawn up on this basis reached me, except in the case of Dar-el-Ramad Canal, where a special case was pleaded in consequence of the large fig plantations which it was pretended could not be subjected to rotation without serious damage to the crop and trees.

It was at first decided not to subject cattle "Sakyahs" to rotation, but it was found afterwards necessary to do so, and the general feeling was that they should be so subjected.

[illegible] — During the [illegible] supply, Major Brown made arrangements for a stoppage of the Engines on the Bahr Yusif. This had never been [illegible] Bahr Yusif [illegible] The Ministry of the Interior [illegible] to the Mudirs to enforce the stoppage by their subordinates [illegible] successful.

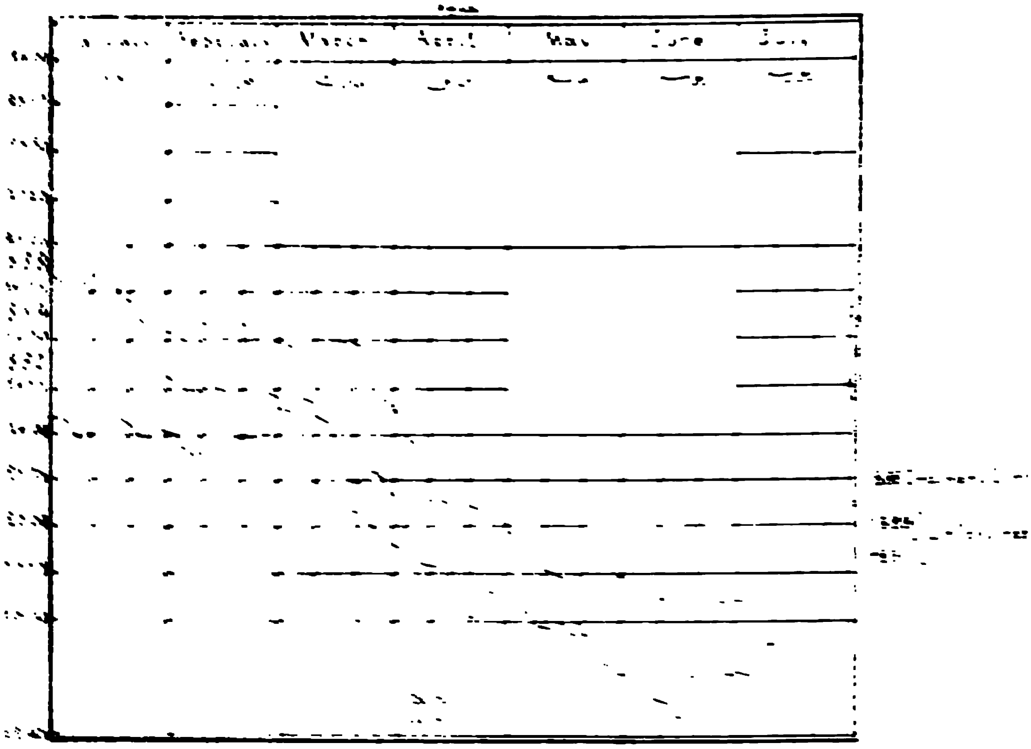
[illegible] — [illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
	[illegible]
[illegible]	[illegible]
	[illegible]

YUSIFI LEVEL

[illegible]



[illegible]

[illegible]

[illegible]

[illegible]

The following table shows the fortnightly summer discharges of the Ibrahimiyah Canal and its Branches in 1890:—

DATE	MARCH 13TH	MARCH 31ST	MAY 3RD	JUNE 2ND	JUNE 24TH
[illegible]	3,165,335	[illegible]	3,162,[illegible]	2,333,306	2,960,454
[illegible]	[illegible]	[illegible]	[illegible]	79,533	145,152
[illegible]	[illegible]	[illegible]	[illegible]	1,331,[illegible]	1,909,5[illegible]1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	365,511
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	763,552
[illegible]		[illegible]	[illegible]	[illegible]	....

[illegible]

Maintenance of Works

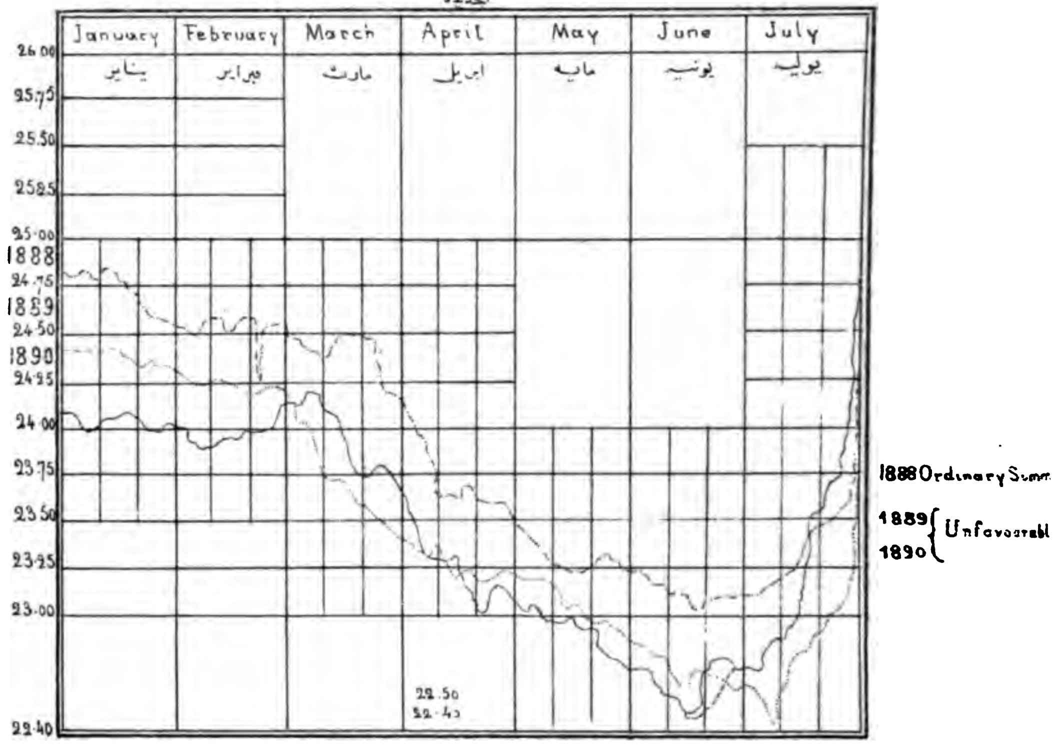
[illegible] —

[illegible] as spurs [illegible] the River [illegible] necessary [illegible] discharging and [illegible]

[illegible] all earthwork done [illegible] the greater part of the money [illegible] [redacted] which [illegible]

YUSIFI LEVEL

Above new bridge Illahun تسوية مياه البحر اليوسفي امام قنطرة اللاهون الجديده



NOTE

This diagram shows that the Fayoum summer upply in the years 1889 and 1890 fron 1st arch to the end of July averaged the same.

The rise after the 17th June 1891 was due to he stoppage of engines and other water lifting nachines from Derut to Lahum, the dotted line hows approximately what would have been he levels, if the engines have not been stopped.

ملحوظه

هذا الرسم يعلم ان متوسط الري الصيفي في مدينة الفيوم كان واحدا
اول مارث لغاية يوليه سنتى ١٨٨٩ و ١٨٩٠
زياده التي حصلت في السابع عشر من شهر يونيه سنة ١٨٩١ كان
ناها توقيف الألات البخاريه والرافعه فيما بين ديروط واللاهون
ط الجزء المرسوم هنا يبين لنا بوجه التقريب منسوب المياه في حالة ما اذا
ت الألات البخاريه والرافعه مستمرة العمل

Lowest levels on Railway Asyut bridge.

57. — The lowest levels reached on the Asyut Railway Bridge at the head of the Ibrahimiyah Canal since 1883, are compared with Aswan thus in the following table : —

YEAR	ASWAN				ASYUT	
	DATE	GAUGE			DATE	GAUGE
		PIC	K.	METRES RED LEVEL		METRES RED LEVEL
1883	21st June	1	15	85.04	13th June........	44.98
1884	26th May.........	2	6	85.37	1st July..........	45.40
1885	21st June	0	18	84.56	26th June........	44.80
1886	3rd »	1	11	84.95	9th »	45.14
1887	5th May	1	12	84.97	13th May	45.26
1888	5th June.........	1	10	84.92	14th June........	44.97
1889	4th »	0	11	84.40	27th »	44.50
1890	28th May........	0	10	84.38	5th and 11th June.	44.43

The level of the water at the Ibrahimiyah head at its lowest is for a fair average summer supply at 45.00. In the year under review, the water fell for 70 days below this average (22nd April to 30th June). In 1889, the duration of the lowest water below 45.00 was 77 days, but the lowest gauge recorded in 1890 was 7 centimetres below the lowest of 1889, so that 1890 may be considered as the lowest year in the past 8 years.

There was less strain felt in 1890 however and this is probably owing to the gradual perfecting of the summer distribution.

Gauge at Illahun.

58. — The diagram opposite shows the gauge at Illahun for 3 years. From this, the rapid fall in March is clearly indicated. It is easy to see that large additions to the Sefi area of the Fayum like the reclamation of the Bahr Wardan tracts cannot be undertaken till the supply of the Ibrahimiyah Canal is largely increased. Nor can the last irrigation of the winter crop be depended on, as the latter fortnight of March is one in which there is demand both for winter Irrigation and for preparing cotton lands.

The following table shows the fortnightly summer discharges of the Ibrahimîyah Canal and its Branches in 1890: —

DATE	MARCH 15TH	MARCH 31ST	MAY 3RD	JUNE 2ND	JUNE 24TH
Ibrahimîyah before distribution at Derût..........	5,165,335	3,514,485	3,162,625	2,333,303	2,980,454
Saheliyah..................	240,537	224,467	88,120	79,833	145,152
Ibrahimîyah below Derût..	3,321,388	1,989,759	2,058,739	1,531,042	1,809,561
Derûtiyah..................	286,156	249,027	231,920	143,127	265,811
Yûsfi at Derût.............	1,317,254	1,051,232	783,846	579,301	743,592
Yûsfi at Lahûn.............	....	1,407,732	930,984	584,064	....

CHAPTER IV.

Maintenance of Works.

Division of maintenance charges into 5 heads.

59. — The maintenance charges are divided into: —

1) *Protection Works against Flood*, such as, spurs in the River: pitching banks: stakes: sand bags, etc.

2) *Maintenance of Masonry Works*, repairs to masonry: replacing regulating planks and timbers: repairs to locks: changing and improving styles of regulation: Inspection houses.

3) *Silt Clearance and Embanking*. This includes all earthwork done in Canals and banks, and on this head the greater part of the money was spent. Under this head is included the cost of spurs when they are made to deepen a canal.

4) *Dams in River* to keep out the salt water.

5) *Pumping water* for Irrigation, etc.

Comparison of maintenance charges 1889 and 1890.

60. — The total maintenance charges of 1890 and 1889 are thus compared: —

	1889	1890
1. Flood Protection Works.........	34,405	48,791
2. Masonry Works maintenance....	26,966	36,215
3. Silt clearance and embanking....	372,162	399,115
4. Dams...........................	28,709	3,244
5. Water pumping................	59,999	49,822
Total......	521,241	537,187

In 1889, there was a partial Corvee.

The cost of the Silt clearance and embanking is paid for out of the L.E. 400,000 alloted to the Corvee Relief. Part of the cost of the salt water dams is also charged to this head.

After the sums for the maintenance of the works are alloted and after the cost of the "Personnel" is deducted, the balance is alloted to original Works.

It will be seen on referring to their chapter that original Works in the Delta were very few this year. There was so large an amount of repairs and alterations to be done to the Regulating Works that a large sum had to be diverted from original Works to Repairs.

Excessive expenditure 1890.

61. — The amounts entered therefore under the head of repairs and maintenance of existing works are far in excess of the normal. The cost of protection, maintenance, and repairs is as follows: —

NAME	NILE PROTECTION	MAINTENANCE MASONRY WORK	TOTAL
1st Circle....	9,831	9,831	19,662
2nd »	11,150	15,388	26,538
3rd »	6,189	4,276	10,465
4th » and Fayum	19,041	4,492	23,533
Girga...	973	1,464	2,437
5th Circle...	1,607	764	2,371
TOTALS....	48,791	36,215	85,006

1st Circle.

Flood protection expenditure.

62. — For Nile protection spurs cost L.E. 2,801. The stone and brick used in them was 12,050 m³.

L.E. 1,544 were spent on stakes, sacks, etc., and L.E. 1,108 were spent on reserve of stone.

L.E. 3,625 were spent in paying for the arrears of 1889 in stone purchases. This stone was not used in Nile spurs, but on protection of the new Rayyah Taufiqi.

8,069 m³ of stone was recovered from the Benha and Mit-Ghamr sadds which were no longer used this year. The recovery cost L.E. 811.

Masonry Repairs.

63. — In repairs to Bridges, there was much done of a remodelling type. The old vertical regulation was abolished, horizontal plank regulation adopted, and the floors raised and the Bridges rendered thoroughly sound.

The Bridges treated were : —

Sharkiyah Province.

Kafr Saqr and Singahah Regulator.......	L.E.	616
Abu Shaqâq Regulators................	»	539
Bahnâbâi Head........................	»	174
12 minor Heads on Mît Yazîd...........	»	603
Mustagaddah Sefi Head................	»	99
Tissa Regulator at Zagazig............	»	436
Khalîli Mustagaddah...................	»	180
Abu Tubûl............................	»	207
Burden Head..........................	»	75
Total......	L.E.	2,929

These works gave 27 existing Regulators altered. Sharkiyah is now far in advance of the two other Provinces.

Dakahliyah Province.

Four heads on the Sahil Canal were pulled down and rebuilt...	L.E.	1,207
Two heads on the Buhiyah group..........................	»	365
The Bahr Tanah Head in Mansuriyah Canal, repaired and fitted with horizontals..	»	511
Farsaskur Regulator..	»	279
7 Heads were thoroughly repaired on Bahr Saghir group......	»	625
The Hagazah and Shokah Heads on Faraskur Canal, repaired...	»	64
The Hammamah Regulator on Buhiyah Canal, turned into a road bridge..	»	64
The Mansuriyah Canal Head was pulled down and Floor raised to 5.50. It will be fitted with iron gates to regulate either way. Spent in 1890..	»	1,141
Total....	L.E.	4,256

For this sum, 19 Regulators were put into thorough order.

In Kaliubiyah, nothing was spent in repair of a serious character.

In this Circle, there were repaired 46 masonry works which cost, in all, L.E. 7,185. This may be looked upon as an abnormal expenditure. In addition to this sum, there was spent in the three provinces L.E. 2.238 in petty repairs and trifling alterations.

2nd Circle.

Flood protection expenditure.

64. — In this Circle, there was spent the sum of L.E. 6,201 in Menufiyah and L.E. 4,949 in Gharbiyah, i.e. a total of L.E. 11,150; of this sum, L.E. 1,454 were spent on putting spurs in the Rayyah Menufiyah.

In the Rosetta Branch in Menufiyah on stone......	L.E.	2,886
In the Rosetta Branch tn Gharbiyah on stone......	»	2,313
Total......	L.E.	5,199

In the Damietta Branch in Menufiyah	L.E.	1,334
In the Damietta Branch in Gharbiyah.............	»	2,636
Total......	L.E.	3,970

L.E. 527 of sacks were used.

The sum of L.E. 2,996 was also granted from special Budget for spurs in the Rayyah Menufiyah which is not included under this head.

Masonry Repairs.

65. — In the 2nd Circle, in continuation of last year, the thorough repairs to the great regulators on the Bahr Shebin were completed. They are: Karanen: Rahbên: Demerah. The Nashart Regulator on the main western Canal, the Baguriyah at its entrance into the "Birriyah", was also repaired. Also the Salahib Lock. The Birshams head was altered at a cost of L.E. 1,706.

The total cost af these repairs was L.E. 9,229.

A number of smaller heads were repaired at expense of L.E. 5,336.

The remainder of the sum of L.E. 15,394 was spent on Inspection house repairs and rent 371 L.E.: maintenance of Regulators L.E. 452.

3rd Circle.

Flood protection.

66. —

Spurs in Beherah cost	L.E.	2,923
Spurs in Gizah cost	»	1,782
Total...	L.E.	4,705

Masonry Repairs.

67. —

In Beherah, repairs of bridges		»	450
Petty repairs to bridges		»	176
Pitching the holes below 7 bridges		»	162
In Gizah, repairs of 9 Regulators		»	1,200
Pitching holes for above		»	265
Repairing Rayyah Head		»	1,209
Protection and various maintenance of Rayyah		»	905
Inspection houses Gizah	L.E. 170	»	306
Inspection houses Beherah	» 136		
Regulation of Behera bridges	» 276	»	284
Regulation of Ghizah bridges	» 8		
Surveying and measurements of Canals		»	224
Protection Bahr-el-Ama, near Cairo		»	424
Maintenance of Abuqir Sea wall		»	155

Dams.

68. — The Rosetta Branch dams cost 3,244 L.E., of which L.E. 105 for the Khatatbah and L.E. 3,139 were allotted from this head to the Mehallet El-Amir.

This is the last time the Khatatbah dam will be put in.

The repairs to the Rayyah Beherah head were executed with great difficulty.

4th Circle.

Flood protection.

69. — The sum of L.E. 12,316 was spent on stone for revetment of basin Banks and repairs to existing revetments.

Masonry Repairs.

70. — River training cost only L.E. 903 $^1/_2$ including L.E. 356 on sacks.

In masonry Repairs, 4 Bridges in Asyut were put in order at a cost of L.E. 548 and L.E. 969 in the Fayum chiefly on "Nasbahs".

A very large expenditure was incurred in protecting the downstream holes of Bridges principally in Asyut, amounting to L.E. 2,481, of which L.E. 367 is for the Illahun Bridge at the entrance to the Fayum and the remainder in Asyut.

L.E. 5.646 were spent on Ibrahimiyah Canal spurs.

L.E. 111 for stone to Canal heads.

Girga.

Flood protection.

71. — L.E. 760 were spent for the Nile Bank and basin bank stone protection :

Masonry Repairs.

72. — L.E. 1,264 on timber and Bridge Regulation necessaries : L.E. 213 on stone for Canal heads: and L.E. 192 on repairing three Bridges.

5th Circle.

Flood protection.

73. — L.E. 1,607 were spent on river protection including spurs at Armant and Assuan.

Masonry Repairs.

74. — L.E. 722 on repairs to 6 Bridges.

Earthwork Maintenance, Silt Clearance, and Embanking.

Definition of Earthwork Maintenance.

75. — This head includes all repairs which are rendered necessary by the degradation of Banks by waves, breaches, or passage of men and animals. Also all clearances of silt or mud deposits in all the public canals.

Abolition of Corvee. — Sum required and allotted.

76. — When the Corvee was abolished in the beginning of 1890, it seemed an extremely hard task to confine the expenditure to the L.E. 400,000 promised by the Finance in exchange for Corvee Labour. The Corvee figures in excess of the L.E. 250,000 given in aid of the Corvee pointed to a total expenditure of L.E. 250,000

more, and it was only a knowledge from experience of the worthlessness of these figures that I was able to consent to try to maintain the Irrigation system with the L.E. 400,000.

Difficulties in allotment of Corvee Grant.

77. — There were many difficulties in the way: —

1) The awakening of Upper-Egypt to demand a more perfect system of Nile Flood distribution.

2) The natural and legitimate desire of the Middle-Egypt Basin Landowners to get more red water.

3) The immense expansion of cultivation in the Delta, in all the three Circles, causing the clearance and maintenance of Canals and drains which had been abandoned under the Corvee.

4) The changes made in the summer regime of the two branches of the Nile rendering necessary a large expenditure in bringing water along the Banks of the Nile to irrigate the lands deprived of summer water by the inflow of salt from the Sea.

5) The increased maintenance charges on the extended system of Drains dug by Loan Money.

All these charges supplemented by a constant desire of every Inspector to push his legitimate improvements as fast as possible rendered the task of limiting the Repair expenditure to L.E. 400,000 very difficult.

Future distribution of Corvee Grant.

78. — From a comparison of figures for several years combined with the knowledge of what economies are effected by ameliorating the Canal system in Upper-Egypt, I have, after consulting the Inspectors, come to the following distribution of the L.E. 400,000.

The distribution also shows the expenditure if all improvements were to be checked and were we to abruptly cease to protect the Banks with stone revetments.

NAME OF PROVINCE OR SPECIAL WORK	SHARE OF L.E. 400.000		COST WITHOUT IMPROVEMENTS	
	L. E.	BY CIRCLE	L. E.	BY CIRCLE
Wadi Halfa and Assuan	1,500	....	1,200	....
Kena and Isna	45,000	46,500	37,800	39,000
Girga	34,000	34,000	30,000	30,000
Asyut	31,000	....	28,000	....
Ibrahimiyah Canal	25,000	....	25,000	....
Minya	31,000	....	27,000	....
Beni-Suef	18,000	....	15,000	....
Fayum	12,000	117,000	10,000	105,000
Gizah	10,000	....	7,000	....
Rayyah Beherah	20,000	....	15,000	....
Beherah	23,000	....	18,000	....
Dams in Nile	4,000	57,000	4,000	44,000
Menufiyah	....	....	....	....
Gharbiyah	....	63,000	....	58,000
Ismailiyah Canal	....	....	....	....
Sharkiyah	....	....	....	....
Dakahliyah	....	....	....	....
Kaliubiyah	....	75,000	....	70,000
Reserve	....	7,500	....	4,000
		400,000		350,000

I am myself much opposed to any reduction of the L.E. 400,000 unless the L.E. 50,000 is allotted under other parts of the Public Works Budget.

Were this the case, the works of amelioration and improvement could be entered as Original Works. The present meagre Original Works Budget expenditure of about L.E. 50,000 a year is altogether unable to furnish money for this class of work. The Repair expenditure also which amounts to nearly L.E. 100,000 cannot be safely diminished, as it is absurd to suppose that the immense numbers of Masonry Works built under the Million and Sharaqi-Drainage Loan will not require repairs in the future.

Works of amelioration.

79. — There will be seen in the notes on the various Mudiriyahs the expenditure on works of the class of amelioration. In the two southern Mudiriyahs, the amount done has been very large indeed. But it must not be forgotten that in digging a new Canal, we often save in repairs of its banks which are basin Banks and in digging new minor distributary, we save on repairs of banks and clearance of the old abandoned works.

The following notes on the various Mudiriyahs and Circles of Irrigation must be read therefore with a reserve as to the amount of repairs required in the future, when there are no new works going on.

Original distribution f Corvee Grant.

80. — The amount of repair money allotted to each Circle has been based originally on the amount of Corvee work done in the years 1884-1887, including the money devoted to the alleviation of the Corvee.

Each Circle has had to cut down its expenditure to these artificially produced limits. Unfortunately Behera: Dakahliyah: and Minya never did their work, and thus these three Provinces merit a great share of the L.E. 150,000 that finally did away with the Corvee. The attempt to show comparisons per acre of cultivated or per taxed area or per head of population is useless in making comparison of allotments. Even in the comparison of length of Canals and Banks, there is not much advantage, save that it shows that one Province has either too many or too few Canals. To decrease Canals is an infinitely difficult task leading to endless law suits. To increase canals requires special loan, unless they are made very slowly by the small sum available in the Corvee Grant for ameliorations.

The utmost that can be done by the Central Controlling Authority is to study by its own unique general knowledge each Province natural advantages or disadvantages and check the natural tendency of the local authorities and landowners to do their best to better their conditions.

I give in the appendix data furnished by the Finance showing the basis for statistical comparisons should they be worked out in future. Also a commencement of comparative tables.

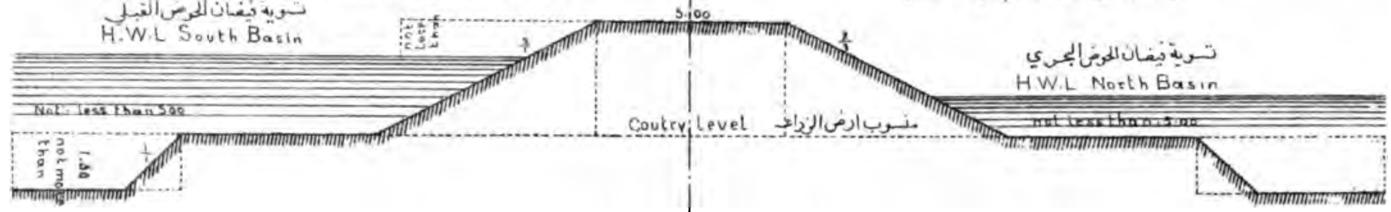
Basin Banks Standard section.

81. — The work of bettering the standard of work and bringing banks to a full standard section was initiated in 1884 by a circular of Sir Colin Scott Moncrieff laying down the standard profiles. This standard profile was however too narrow at top to serve as a road for camels laden with cotton or "dura" stalks. The flat slopes of $\frac{3}{1}$ and $\frac{4}{1}$ adopted for river banks in most European coun-

N:1

SALIBAH WITHOUT REVETMENT

هيئة جسر صليب بدون تكسيه



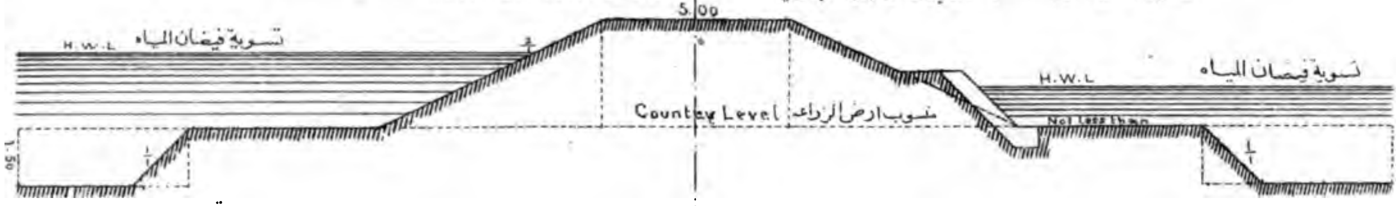
N:2

جنوب South

SALIBAH. WITH STONE REVETMENT ON NORTH SIDE

هيئة جسر صليبه مكسية بالاحجار من الجهة البحريه

North شمال



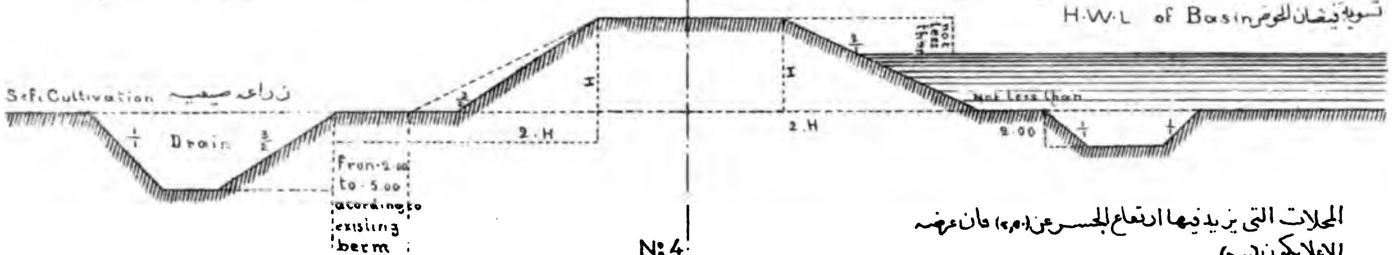
شرق EAST

N:3

غرب WEST

MOHIT - TO BE MODIFIED AS N:2 IF STONE REVELTING

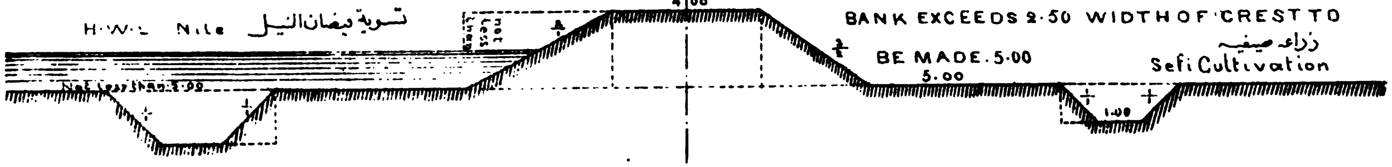
هيئة جسر محيط يعدل كقطاع (نمرة ٢) في حالة استعمال التكسيه بالاحجار



N:4

NILE BANK WATER ON RIVER SIDE ONLY

جسر البحر الاعظم من جهة النيل



N.B. IN PLACES WHERS THE HEIGHT OF THE BANK EXCEEDS 2.50 WIDTH OF CREST TO BE MADE 5.00

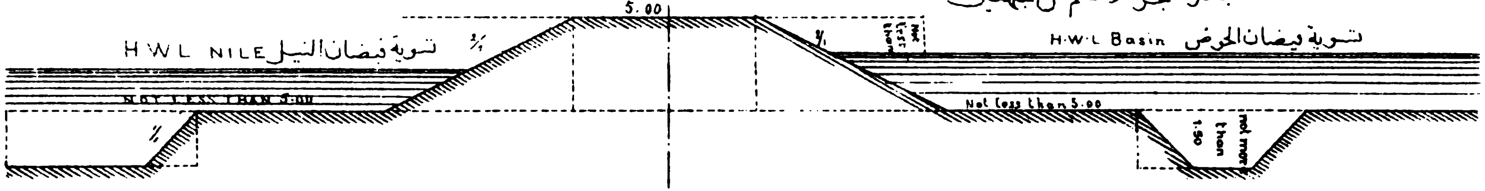
المحلات التى يزيد فيها ارتفاع الجسر عن (٢,٥٠) فان عرضه الاعلا يكون (٥,٠٠)

4th CIRCLE تفتيش دي القسم الرابع

TYPICAL GROSS SECTIONS OF BANKS AND CANALS اورنيك قطاعات عرضيه للترع والجسور

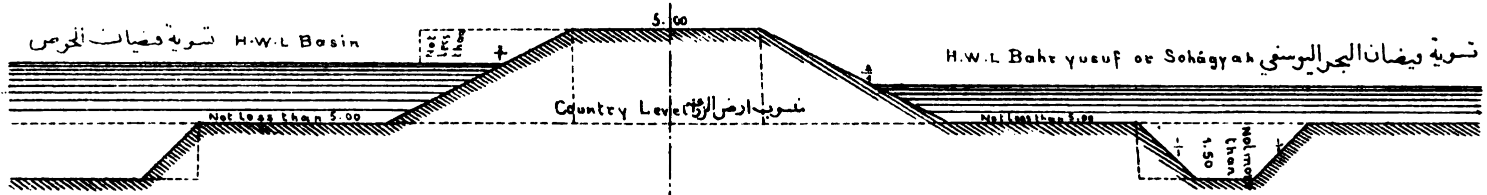
No 5

NILE BANK WATER ON BOTH SIDE جسر البحر الاعظم من الجهتين



N:6

TARAD OF BAHR YUSUF AND SOHÂGIYAH طراد للبحر اليوسفي او الترعة السوهاجيه


5.00
تسوية فيضان الحوض H.W.L Basin
Not less than
Country Level تسوية ارض الزراعة
Not less than 5.00
H.W.L Bahr yusuf or Sohâgyah تسوية فيضان البحر اليوسفي
Not less than 5.00
Not more than 1.50
1

No 7

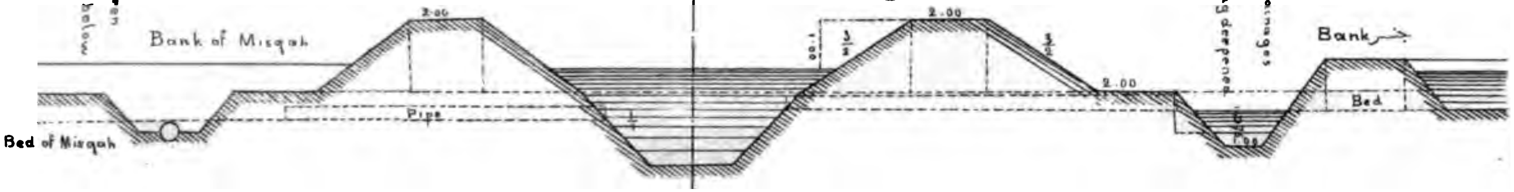
حالة تقاطع المصرف بمسقة
حيث تمر مياه المصرف من
تحتها بواسطة ماسورة
من حديد

Misqah crossing between
banks drainge passung below
it by iron pipe

حالة تقاطع المصرف بمسقة حيث
تمر مياه المسقة من بدالة مع تعميق
المصرف لسهولة مرور مياهه
من البدالة

Misqah crossing over drainages
by aqueduct drain deing deepened
to pass below aqueduct

SEFI DISTRIBUTARY CANAL WHERE PERCOLATION EXISTS هيئة ترعة صيفية مارة باراضي بها مياه رشح

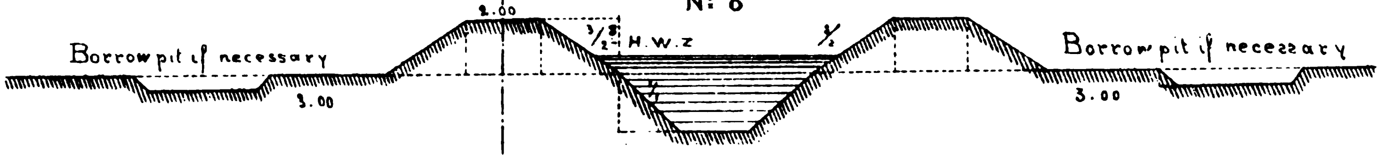


4th CIRCLE تفتيش ري القسم الرابع

TYPICAL GROSS SECTIONS OF BANKS AND CANALS اورنيك قطاعات عرضيه للجسور والترع

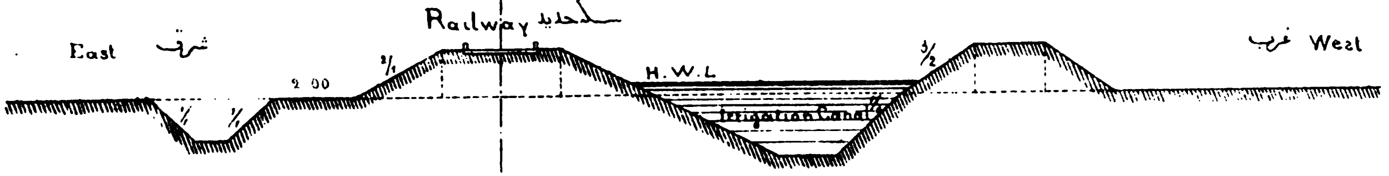
SEFI CANAL WHERE NO PERCOLATION EXISTS ترعة صيفيه ماره باراضي ليس بها مياه رشح

N° 8

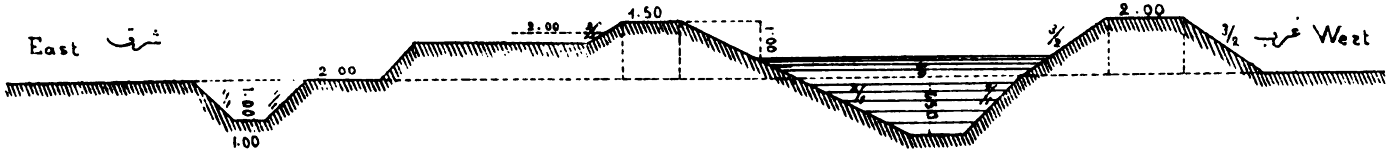


N° 9

AGRICULTURAL RAILWAY CANAL ON WEST DRAIN ON EAST سكحديد زراعيه غربها الترعه وشرقها المصرف



N° 10



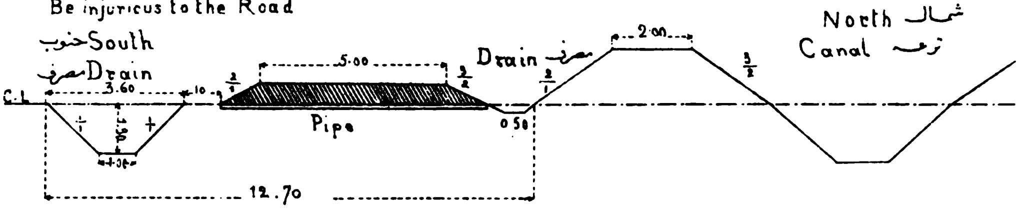
TYPE SECTION for Agricultural Roads: ارانيك قطاعات عرضيه للسكك الزراعيه

N°1

Alongside a Canal حالة ماتكون السكه الزراعيه حذا ترعه

Section to be adopted in Soils where in filtration from the N ighboring Canal would Be injuricus to the Road

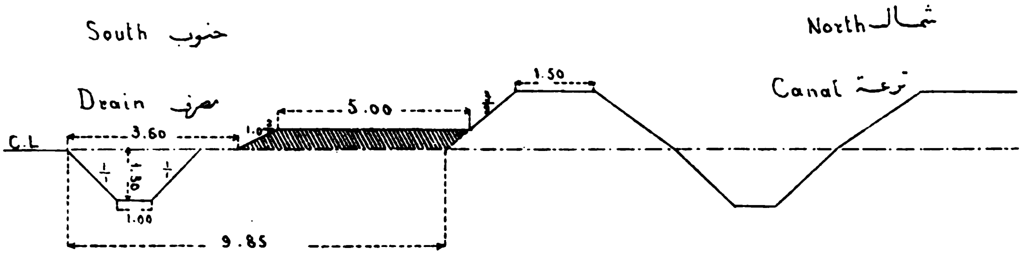
فى حالة مايكون هناك رشح من الزراعه المجاوره ويخشي من اتلاف الطريق



N°2

Section where no infiltration is to be feared

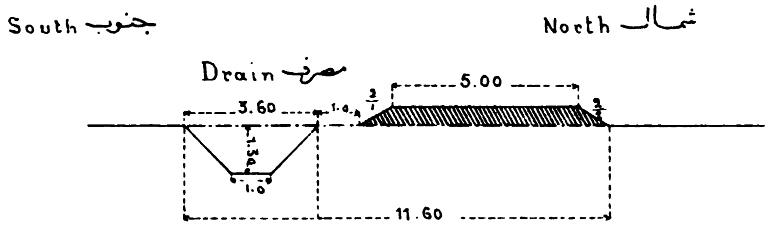
فى حالة مالم يكن هناك رشح يخشي منه



N°3

Section across land where no bank Previously exists

فى حالة مالم يكن هناك جسور من قبل



TYPE SECTIONS for A.GRICULTURAL SECTIONS ادانيك قطاعات عرضيه للسكك الزراعيه

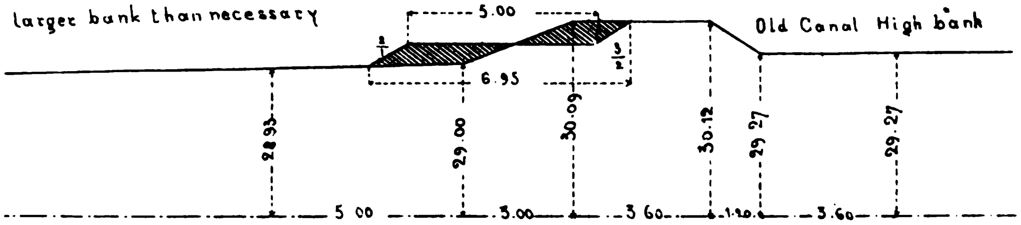
جنوب South

N° 4

شمال North

Section alongside old Canal which has a larger bank than necessary

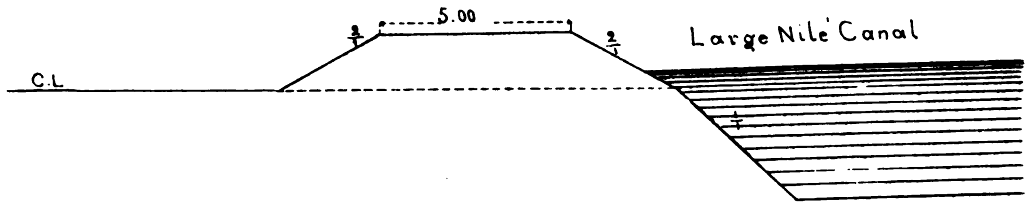
في حالة مايكون هناك ترعة قديمه جسورها زياده عن اللزوم



N° 5

Road along top of large Nili Canal bank Such as nina or Kholussi Canal

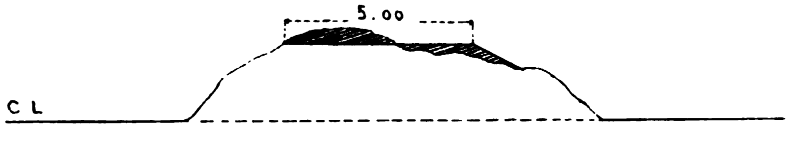
في حالة ما اذا كانت السكة علي سطح جسر الترعه النيليه كترعتي نينا وخلوصي



N°.6

Road along top of old Basin or other Large bank

في حالة ما اذا كانت السكة الزراعيه علي سطح جسر الحوض او اي جسر اخر كبير



tries were found to be too expensive to make, as it would have led to the filling up of all the immense borrow pits made by the Corvee during the last 30 years.

A compromise was made and the final standard section was adopted in the 4th Circle by Major Brown who has devoted much care to his banks. He has been able to do so, as in the Middle Egypt Mudiriyahs, the Canals are not costly. A series of these final standard sections is given in this Report.

Wear and tear of Banks.

82. — The principal agents of wear and tear on banks are the waves of the basins. These, in an ordinary high Nile, cut away fully 4 square metres per metre run, notwithstanding the efforts of the Nile Corvee to protect the slopes by " dura " stalks, brushwood, and grass. In the Delta, the Nile Corvee is far more efficient, and with their stakes and brushwood do a great deal to preserve the bank of the Nile from wash. In a very long continued high Nile in Upper Egypt with the water standing 60 centimetres over the ordinary level, the people despair of protection, and in many cases, the bank is wholly washed away and beaten down into a round mound.

In any cases, the earth from the slopes is carried down to the bottom of the slopes and deposited in a glacis at a slope of $\frac{1}{10}$. In some cases, the earth is washed of its clay and pure sand is left, leaving a sandy foreshore liable to wind drift. When the borrow pit was immediately under the slope, all this washed earth fell into it and the Corvee took it up again, and so the process was continued ad infinitum.

Much has been done in Upper and Middle Egypt in removing the borrow pits to 7 metres or more from the bank toe, and I see already a sensible diminution of the wave action, as the glacis on $\frac{1}{10}$ no longer falls into the pits. The only danger now is the creation of sand drift foreshores which in some cases may spoil a considerable amount of land.

Major Brown has made many attempts to plant reeds and coarse grass on the southern slopes where the waves do not beat. An experiment he made several years ago, near Suhag on the Suhag

lower class
ways too much
would recommend,
this work, as it binds
ng down after the Nile
g of the earth in drying.

andard section as adopted in

	EEP WATER FACE IN ONG. BANK	NABARI SIDE OF A BANK	SOUTH FACE CROSS BANK
	3/2	1/1	1/1
	2/1	3/2	3/2
	1/1	1/1	2/1

face is 3/2 and the country side 3/2, but the
top.

Suef, the Yusifi banks are still defective in
anks are still somewhat narrow.

ng notes are made in each Mudiriyah to show
the Loan and Repair allotments and to show
d in ameliorations.

h of Kena and Girga, the great amount of amelio-
ordinary Corvee allotment has had the sanction
Ministers who ruled that, as far as possible, the
construction of the Canals and Banks rendered
Project of 1888 were to be done by the Corvee or
devoted to alleviation of the Corvee, and that the Loan
to be applied to earthwork, where the work was
ond the limit of the ordinary allotment.

1st Circle.

Earthwork maintenance.

85. — There were few new works or works of amelioration paid for from the Corvee Money.

The only items are: —

Embanking Gabbadah Canal..........	74,159 m³ =	L.E. 1,781
Rayyah Tewfiki junctions............	42,135 » =	» 426
Rodah (Cairo) clearance of channel Suez branch	21,096 » =	» 1,355
	Total.......	L.E. 3,562

Total expenditure of Corvee Grant.

86. — The total expenditure on Corvee grant inclusive of the above L.E. 3,562 was as follows: —

3,057,044 m³ = L.E. 73,425. This includes dredging.

87. — The following table shows the dredging of the Ismailiyah Canal for the past four years: —

Name	1887	1888	1889	1890
Kasr-Nil Branch	64,598	Nil	7,444	Nil
Shubrah Head..................	69,017	42,778	47,637	65,340
Shubrah-Syriyakos............	196,367	82,189	17,129	108,307
Syriyakos-Belbeis.............	Nil	110,935	109,361	24,507
Belbeis-Neflsha.................	Nil	Nil	Nil	1,869
Rayyah Menayir	10,172	Nil	Nil	Nil
Totals....	340,153	235,902	181,571	200,023

Dredging of the Ismailiyah Canal.

The Kasr-Nil Branch being a Nili Canal now is struck out of the dredging list in 1890.

Mr. Garstin holds to his opinion that the first Circle must not look for economy for two or three years to come, as it is very backward in scientific arrangements in Kaliubiyah where large summer Canals are run 4 to 5 metres deep with a low velocity by means of Regulators to keep the Nile Flood water above the Land. There are practically no escapes for the Kaliubiyah Province and its surplus water only floods Sharkiyah.

2nd Circle.

Earthwork maintenance.

88. — In the 2nd Circle, the rates are high compared with other Circles. The work executed is a minimum in quantity, owing to the careful manipulation of the Canals by Mr. Willcocks.

Mr. Willcocks details his expenditure thus: —

Sefi Canals..........	851,000	at 0.027 =	22,666
Nili Canals..........	672,000	at 0.013 =	8,438
Nile Banks..........	327,859	at 0.020 =	6,597
Drainage cuts.......	403,163	at 0.020 =	8,064
Dredging Rayyah....	103,750	at 0.039 =	4,069
New Works.........	365,000	at 0.018 =	6,599
Totals...	2,722,772	0.021	56,433

This total is exclusive of maintenance: Spurring Rayyah and arrears.

A sum of L.E. 2,144 was spent on spurring the Rayyah Menufiyah in addition to the sum of L.E. 1,454 spent on this head under Repairs (Nile Protection) and a further sum of L.E. 2,996 under a special Budget Grant. Thus there was spent 6,594 in all on spurring the Rayyah. This work is of the greatest importance, as this is the only way of keeping the deep summer channel open in the light soil reaches.

The large sum of L.E. 5,062 was spent on maintenance, i. e. closing and opening Regulators in rotation periods, etc.

This large expenditure does not occur in other Circles. It is to be hoped that Mr. Willcocks will in future be able to work his regulators more cheaply.

Works of amelioration.

89. — The new works on which the sum of L.E. 6,599 was spent consist in: —

1) The re-opening of the Safti Canal for 20 kilometres to supplement the tail of the Qasid Canal. This Canal was restored from an

old line. It now takes the water of the Baguriyah Canal across the system to supplement the water coming from the Bahr Shebin.

2) The old bed of the Nile which was like an enormous trench across the province of Menufiyah was connected with the Rayyah and now stores water for use in summer at the tails of the Nanaiyah and Sirsawiyah Canals.

3) The Bahr Sef was connected with the Batunaniyah Canal and irrigated its area much more successfully than before.

4) Some extra silt clearance was done with a view to deepening the Hutt Canal running along the Left Bank of the Damietta Nile from Sherbin to Damietta.

3rd Circle — Behera.

Earthwork maintenance.

90. — The Rayyah Behera swallows up by far the larger part of the money allotted to this province.

The sum of L. E. 61,809 spent in the province is divided as follows:

Ordinary repairs, exclusive of dredging.	L.E.	8,420
Dredging (exclusive of Rayyah)........	»	8,196
Dredging Rayyah....................	»	37,000
Improving Khandak El Gharbi.........	»	2,298
Share of dams.......................	»	5,073
Share of protecting Rayyah Beherah...	»	472
Miscellaneous.......................	»	350
Total...	L.E.	61,809

Works of amelioration.

91. — The improvements or ameliorations are: —

Continuing Khandak-el-Gharbi widening. This consisted of digging 11 kilometres to a bed width of 4 metres. The discharge was doubled; a considerable amount still remains to be done. Three small Canals were also widened.

The Rayyah protection was kept well in hand; much was done in planting grass and willows.

The spurs are very efficient and the sand drift much lessened. But the very greatest care and watchfulness are required to guard against any commencement of a curving channel.

Mr. Foster made the experiment of confiding the clearance of sundry small Canals to the owners of property irrigated by the Canal. Thus self-interest helped to insure a good clearance. Nine Canals were thus cleared. The estimate was made and priced at the Contract rates. Payment was made after the Canal was found well cleared.

Rayyah.

92. — The L.E. 37,000 representing the money paid from Corvee to the Corvee Relief to the Rayyah Behera represents a normal clearance of about L.E. 15,000 and L.E. 22,000 of improvement. This sum of L.E. 22,000 was augmented by L.E. 38,429 from the Loan money. Thus by concentrating this large sum on the Rayyah, we were enabled to dispense in April with the Khatatbah pump, saving L.E. 12,800. Pumping has not been resumed since the Nile, and in 1891, it is practically certain that we will not pump.

The following table shows the progress of dredging in the Rayyah:

Nº of Sect.	Position		Dredgers employed	Period of Work		Quantities Dredged			
	From	To		From	To	1889-90	1888	1889	Total
I.	Nile......	Hd.Sce.	Nº 216.....	...	...	10,648	16,876	12,999	40,523
II.	Hd.Sluice	Kilo. 12	Nº 48, 216 sand pumps	5.7.89	13.5.90	414,868	248,198	64,984	728,050
III.	Kilo. 12..	Kilo. 25	Nº 48, 20 sand pumps	24.7.89	28.6.90	477,544	233,547	309,751	1,020,842
IV.	Kilo. 25..	Kilo. 41	Nº 20, 48, 216 sand pumps	5.7.89	17.7.90	497,648	92,238	2,955	592,881
					Totals.....	1,400,708	590,859	390,729	2,382,296

The section to be dredged for 1890 was 20 metres bed R. L. at head 11.00 Richard. Slope $\frac{1}{20.000}$.

The estimated quantity was 1,300,000 and the actual 1,400,000 m^3.

The Rayyah is closed during the Nile and thus a special dam service is rendered necessary costing L.E. 1,061. There are 3 dams:

1) The head dam.
2) Dam at kilom. 12.
3) Dam at kilom. 32.

3rd Circle — Gizah.

Earthwork maintenance. Small allotments and future increase.

93 and 94. — This Mudiriyah has for the past 5 years been worked by Mr. Foster at the lowest possible figure.

The allotments for the 3rd Circle have been always absorbed by the imperative demands of the Rayyah Beherah ameliorations. Thus, though in past years the province of Gizah is shown as costing L.E. 40,000 and upwards every year, the real province of Gizah only enjoyed the benefit of L.E. 7,000 or thereabouts.

The height of the Nile Flood above the valley and the low state of cultivation in the province renders the maintenance of Gizah cheaper than the maintenance of the same area in Middle or Upper Egypt. At the same time, it must not be forgotten that an inferior state of canalization has led to considerable unpoverishment of land owing to absence of red water and has cast a grievous burden on the people who have for many years been accustomed to use "Shadûfs" in many parts of the province all through August up to 20th September.

The province deserves therefore a larger grant for the next two years than it has had for the last seven.

The expenditure of 1889 was L.E. 7,573 against L.E. 6,392 of 1890. The future expenditure should be at least L.E. 8,000.

Details of earthwork Gizah Province.

Name of Markaz	Salibahs or Cross Banks		Longitudinal banks of basins Tarrads		Nile Banks		Total repairs to banks	Repairs to cuts	Silt Clearances		New works	Total Cubes
	Old	New	Old	New	Old	New			Nili	Sefi		
Gizah	10,847	..	13,895	..	11,014	..	35,756	3,133	52,984	..	..	91,873
Badrshen	29,248	..	64,339	..	15,704	..	109,291	..	22,277	..	..	131,568
Rayyâh	29,170	..	20,661	..	43,003	..	92,834	..	97,432	..	..	190,266
Total West Gizah...	**69,265**	..	**98,895**	..	**69,731**	..	**237,891**	**3,133**	**172,693**	..	..	**413,707**
1st Atfih	...	..	1,265	..	19,479	..	20,744	..	51,602	..	..	72,346
2nd Atfih	1,111	..	1,846	..	30,585	..	33,542	2,032	17,014	..	..	52,618
Total East Gizah...	**1,111**	..	**3,111**	..	**50,064**	..	**54,286**	**2,032**	**68,646**	..	..	**124,964**
Total Gizah...	**70,376**	..	**102,006**	..	**119,795**	..	**292,177**	**5,165**	**241,339**	..	..	**538,671**

4th Circle — Asyut.

Earthwork maintenance.

95. — In the work executed for Asyut, the figures show a slight decrease in total over 1889. This is notwithstanding the removal of 331,059 cubic metres from the Khizndariyah Canal, of which probably 250,000 is really new work. The Sayyalah Dêbis was widened by removal of 50,000 m³ to bring the water from the Mahgar Gebel-el-Haridi. Excluding new works, the work of the Mudiriyah was about 1,616,066 costing about L.E. 22,295.

The great longitudinal banks of the Beni-Smia and Zannar basins are revetted, and thus this Mudiriyah shows a smaller figure than Girga. This Mudiriyah has been practically quite set in order with its banks to full section. Stone pitching is being introduced, and in two years, the expenditure will largely decrease.

The straightening of banks, preparatory to revetting them with stone has been done in three banks taking 127.423 cubic metres.

4th Circle — Minyia.

Earthwork maintenance.

96. — In Minya, the new works were very small. The figure of L.E. 26,059 is not too much for the province. The amount of work executed under the head of new works only amounts to 103,385 m³ in which was included the cost of the restoration of two cross banks, west of the Yusifi and minor sefi canals.

A further sum of L.E. 5,676 was spent on new drains from the Loan.

In this province, the cross banks are in good order on the new section. There still remains however much to be done in bringing the Yusifi banks up to section and in restoring the banks west of the Yusifi.

A large amount of petty work in silting in Canals and digging minor Canals has yet to be done.

In the earthwork, the special work on the Abu Baqara red water Canal is not included in the Table. It is 138,889 m³ costing L.E. 1,600. This Canal will be finished in 1891.

4th Circle — Beni-Suef.

Earthwork maintenance.

97. — In the Beni-Suef Mudiriyah, the amount expended is about ordinary. There has been some economy owing to the revetting of the two northern Salibahs and more revetting is going on.

The Qusheshah Cut figures for the last time.

The new works are large 256,289 m^3. They are: —

New Sefi Canals	95,000 m^3
Drains in Biba Teftishe	30,355 m^2
New Bank Bahr Yusif	61,294 m^2
New Nile Bank	12,671 m^2

The remainder is due to minor works.

There are also 79,775 cubic metres representing arrears on drains in 1889.

L.E. 1,342 were spent on new drains.

4th Circle — Fayum.

Earthwork maintenance.

98. — No new works of any consequence were undertaken, and the Province was maintained in good order and much improved for L.E. 10,654.

Some very desirable changes in alignment of Canals should be taken in hand in 1891.

4th Circle — Ibrahimiyah Canal.

Dredging.

99. — The cost of this is debitable to the four provinces of Asyut, Minya, Beni-Suef, and Fayum. The work was very satisfactorily performed. There has not been much additional light thrown on the action of the spurs during the current year.

The following statistics are of interest: —

YEAR	ASYUT TO DERUT	BELOW DERUT	TOTAL METRES	COST L. E.
1884	818,430	330,268	1,147,690	34,656
1885	605,598	182,314	786,912	35,662
1886	461,363	...	461,363	24,429
1887	523,410	...	523,410	23,639
1888	447,088	...	447,088	16,595
1889	629,022	...	629,022	23,071
1890	493,210	...	493,210	18,135

Spurs.

100. — As regards the spurs, Major Brown notes that a bank of sand is thrown up on both sides of the Canal for a distance of 400 metres below the last spur. It may be argued that as the distance between the spurs is 250 metres, there must be a continuous effect produced by a long line of spurs. Major Brown thinks that if there is a continuous line of 40 kilometres of spurs, the remaining 20 kilometres to Derut will be kept clear in November to February by the draw of the escape.

I myself still think that the spurs are too far apart and that there is in many places a considerable amount of silt above bed line between the spurs, though not so much as was figured in last year's Report.

The expenditure on spurs is shown as follows : —

YEAR	No. OF PAIRS OF SPURS	COST	REPAIRS	TOTAL COST	REMARKS
		L.E.		L.E.	
1886	12	2,112	..	2,112	
1887	14	2,242	95	2,338	
1888	23	3,757	560	4,317	Exclusive of L.E. 1,025 on Railway slopes.
1889	31	4,335	205	4,540	
1890	26	4,696	80	4,776	
	106			18,083	

There are continuous lines of spurs as follow : —

From Mouth te Railway Bridge	7 pairs
» kil. 2.280 to kil. 3.030	4 »
» » 10.000 » 34.000	95 »

Canal Clearances.

101. — The Derutiyah and Sahiliyah Canals have been cleared as follows : —

Derutiyah	73,808
Sahiliyah	96,618
	170,426 m³ costing L.E. 3,547.

The following shows the earthwork in 4th Circle for 1890: —

	SALIBAHS OR CROSS BANKS		LONG. BANKS OF BASINS (TARRAD)		NILE BANKS		TOTAL REPAIRS TO BANKS	REPAIRS TO CUTS AS CLOSURES	SILT CLEARANCES		NEW WORKS	TOTAL CUBIC-METRES	TOTAL COST	
	OLD	NEW	OLD	NEW	OLD	NEW			NILI	SEFI				
													L.E.	M.
South Asyut........	6,861	..	63,987	..	109,588	..	180,436	54,163	255,129	..	323,974	813,522	12,039	803
Central Asyut.......	..	..	..	..	..	..	334,633	7,826	129,021	..	127,903	569,383	7,277	395
North Asyut........	..	..	..	..	..	..	330,303	72,838	93,364	188,353	36,146	721,004	10,295	374
TOTAL.....	..	..	..	..	..	..	845,372	134,827	477,514	188,353	488,023	2,103,909	29,612	572
Minya.............	..	..	..	..	..	..	329,315	20,047	9,989	153,449	832	513,632	6,941	344
Arrears 1889	..	..	..	..	..	..	..	..	..	..	64,152	64,152	801	900
Qulusna...........	..	..	..	..	..	..	369,585	72,069	5,687	71,745	12,084	531,170	7,404	071
Arrears 1889.......	..	..	..	..	..	..	7,867	..	..	..	..	7,867	106	200
Beni-Mazar	..	..	..	..	..	..	153,157	18,526	32,673	187,651	..	392,007	5,479	235
Feshn.............	..	..	..	..	..	..	178,542	3,924	34,396	108,685	26,317	351,864	5,327	208
TOTAL.....	..	..	..	..	..	..	1,038,466	114,566	82,745	521,530	103,385	1,860,692	26,059	958
Biba..............	..	..	..	..	..	..	226,569	..	47,692	37,801	91,649	403,711	5,456	367
Arrears 1889.......	..	..	..	..	..	..	..	..	..	..	79,775	79,775	1,096	921
Beni-Suef..........	..	..	..	..	..	..	75,355	..	234,687	63,561	12,191	385,884	5,349	843
Zawiyah M.........	..	..	..	..	..	..	133,372	..	120,623	..	72,674	326,669	4,242	081
Do Qusheshah Cut.	..	..	..	..	..	..	..	23,285	..	..	..	23,285	622	902
TOTAL.....	..	..	..	..	..	..	435,296	23,285	403,002	103,362	256,289	1,219,324	16,768	114
Fayum............	..	..	..	..	..	..	56,989	..	..	789,665	10,026	856,680	10,653	694

N.B. These figures do not include the Dredging of the Ibrahimiyah Canal.

4th Circle — Girga.

Earthwork maintenance.

102. — In Girga, the works of repair were largely increased as in Kena by the Sharaqi works. The Railway works also largely added to the work done.

The subordinate Staff were much more efficient in their work than Kena, and contractors got their tasks given them without delay.

The amount of work done was very large, and inclusive of the Railway work, amounts to 5,179,711. This cubes includes 430,898 m³ done in the Kena Mudiriyah.

Of this cube, the Railway work is 875,775 m³. This work should be reckoned as Canal amelioration, as the whole of it was executed in widening and digging Canals and making the Railway bank out of the spoil.

The rest of the improvement are 1,653,429 in widening and deepening Canals; 288,367 in new banks; deducting these figures we have 2,362,140 m³ costing L.E. 29,526 which are Ordinary Repairs.

This figure is too large, although not over the Ordinary budget grant of L.E. 30,000, and may be accounted for by a very general raising of the Nile Banks to bring them to the height of one metre above the maximum Flood level indicated by the study of the Nile gauges of 1887, 88, 89.

Canal Clearances 1889 & 1890.

103. — The following table shows the clearances in Canals of supply in the Mudiriyah : —

Canals	Work 1889	Executed 1890	Difference 1890 over 1889	
			More	Less
Kasrah	36,834	46,740	9,906	....
Zarzuriyah	273,321	166,381	....	106,940
Um-el-Tubul	269,435	106,000	....	163,435
Girgawiyah	50,744*	146,652	95,908	....
Haweti	12,769*	....	....	....
Tahta	476,220*	240,107	....	236,103
Shaturah	13,035*	16,235	3,200	....
Hawis	171,427	52,593	....	118,834
Lahaiwah	207,635	44,116	....	163,519
Isawiyah	Not recorded separately	12,432	....	....

Those marked * were done in 1889 by Corvee.

The Tahta, Zarzuriyah, Hawis, and Lahaiwah Canals were enlarged and deepened in 1889. In 1890 in the Tahta, a further deepening took place.

Mr. Joseph on Earthwork.

104. — Mr. Allan Joseph, Director of works and Irrigation at Suhag, has made the following notes on earthwork. They throw considerable light on the works of the Contract System:

The total quantity of earthwork done is 5.179.711 m^3.

This is, I believe, the largest cube which has ever been done by our Mudiriyah, and it should be borne in mind that the above cube in the actual amount done and is calculated from sections taken before the work was commenced and others taken after the work was finished. In former years when the work was done by Corvée, the cubes were generally grossly exaggerated and were quite unreliable, as certain quantities were written down in the Ga'lwal which were far in excess of the work which had to be done. This was not done altogether without reason, as it was found that if the cubes were put correctly, the Corvée was never turned out in sufficient numbers to complete it, but by exaggerating the figures in the Gadwal it was found possible to get the actual quantity of work done, but I do not believe it was ever known what the actual cube done really amounted, as no sections were taken of most of the work.

The usual manner of calculating the work done was to assume that a man did so much per day, and to multiply that by the number of men turned out, but the result obtained is, I am certain, most unreliable.

I have repeatedly heard of cases where whole gang of Corvée had been taken to a canal or bank and there left for several days without doing a stroke of work simply because the District Engineer or Nazir-el-Kism was not there to say how much was to be done.

I myself counted over 500 men collected on the bank of a Canal and was informed that they had been there 4 days awaiting instructions.

The abolition of the Corvée has of course greatly increased the work of the District Engineers and the amount of levelling done this year is very great

The amount of work done in repairs to Banks (both Nile and Basin) does not appear to have been much diminished from other years, but it must be borne in mind that all banks which were repaired were raised to 1. 00 higher than the 1887 flood.

It is impossible to state accurately the quantity of work this incurred, but I reckon that at least 30 per cent of the repairs work may be put down to this so that if the actual repairs work is reduced by that amount, it shows a considerable reduction on former years.

There still remains a considerable length of Nile Bank to be raised to bring it up to 1. 00 higher than the 1887 flood, but a great part of if will, I expect, be done next season.

During half the month of April and the whole of May, earthwork is pratically at a standstill on account of the men being occupied with the harvest. Some of the contractors managed to keep their work going during this period, but very little was done, and I think that the Contractors who entirely suspended work were wise.

If the work could be commenced in December, I am confident that a very much larger cube could be done, and I also think that rates would decrease a little, although Contractors assure me that this season's rates are a minimum, and I do not think that the reliable Contractors will alter their rates next season.

This season's choice of Contractors has proved most satisfactory, and every one of them has completed his work well within time and entirely to my satisfaction.

The Contractor for Suhag District had some little difficulty at the end in getting labor and he had to complete some of his works by daily labor which must have proved very costly to him. This scarcity of labor was caused by a loss of confidence on the part of the men on account of the dishonest practises of some of his employes.

It is most noticeable that the "Fellahin" have infinitely more confidence in Enropean Contractors than in those of their own nationality.

The system of advancing money to the villagers during the off season was largely practised by some Contractors, and I am informed that very few instances have occurred where the men, to whom the money was advanced, have not turned up and paid off their debt by labor.

The knowledge of the native with regard to the nature of the soil at different points is most remarkable, and you would often see a gang of men waiting days to take a task in a place where they knew the soil would be soft, and refusing all offers to take work until their particular piece was given out.

Contractors found that both in canal clearances and also in new work that it was absolutey necessary to give out their tasks in a continuous line, otherwise any lengths which were missed out were refused even at very much increased rates, as the Fellahin always imagined that these tasks had been left unoccupied on acount of the ground being hard, and these always had finally to be taken out by daily labor.

The amount of work which a gang of really hard working men will turn out in a day is almost incredible. I have myself made experiments without the men knowing that I was doing so, and have found that a gang of 10 men in good soft stuff with an average of 20 metres lead will move up to 4 $^1/_2$ m^3 per day per man including the carriers. With the exception of the Suhag Markaz above referred to I received no complaints of dishonest treatment of the laborers on the part of the Contractors, and during my inspections it was most satisfactory to note the good will and confidence which existed between the Contractors and men. The giving out of the work in alternate Districts to native and European has worked well. There is no doubt that the amount of supervision required is far greater with native Contractors than with Europeans; this is, I believe, mostly on account of the fact that the former will not employ good and reliable men to look after their work, as they consider that any so called Engineer is good enough to look after the levelling, etc., etc.

The clause in the contract relating to an allowance for extra depths dug beyond that required is, I consider, a mistake taking into consideration the manner in which the work is given out in tasks. The proper level is always ensured, as the Contractors never pay for a task until is fully to the depth required and the depth of digging given to the men it is always stated at least ·20 more than actually required, for this extra ·20 the men get no extra allowance, so that amount is a clear profit to the Contractor as he gets paid for work for which his men get nothing.

The work being given out at so much per task, and not so much per metre turned out, there is no inducement to the Contractors not to go down to the required depth, but rather the reverse, as it would not pay him to be obliged to go over the work twice, if the final levelling should the bed too high.

The following is a list of works of amelioration and improvement executed in the Girga Mudiriyah, etc., under the Girga Directorate by aid of the Skarâqi loan: —

SYSTEM	NAME OF WORK	CUBES	RATE	COST L.E.
Sahil Farshut..........	Rashwaniyah Canal.............	430,898	54	5,817.122
South Suhag..........	Prolongation do.	310,069	52	4,030.897
Do.	Bindar junction Zarzuriyah......	124,614	51	1,589.438
Do.	Zarzuriyah wideneng............	185,136	51	2,360.436
Do.	Girgawiyah Banks.............	62,641	60	939.615
Do.	Suhag escape..............	50,000	80	1,000.000
North Suhag..........	Comp. property at Suhag.......	...	..	779.259
Do.	Prolongation Girgawiyah........	95,604	50	1,434.060
Do.	Aulad Nuser..................	226,945	50 & 54	2,870.365
Do.	Beni-Hilal Canal..............	30,156	50	376.950
Do.	Tahta Canal (part).............	69,207	50	865.087
Do.	Hod Kilfau Canals..............	25,000	50	312.500
Khyam..............	Tarif Canal.....................	47,592	52	618.696
Akhmim..............	Isawiyah Canal 12-13 kilometres.	180,307	50 & 53	2,338.025
		1,838,169		25,332.450
Advance on Kasra and Rashwaniyah				6,000.000
			Total.....	31,332.450

In addition to the above, the following were executed as new work and charged to the ordinary Budget: —

Hawis.................	Um-Rakhamah Sayyalah........	21,460	52	278.980
Do.	Gebel-Hawis Sayyalah..........	35,596	52	462.748
Akhmim	Akhmim Sayyalah..............	14,326	47	168.332
Do.	Isawiyah Sayyalah..............	32,245	50	466.225
		103,627		1,376.285

Ordinary, anti-Sharaqi, Extraordinary Earthwork executed in Girga Directorate during 1890.

	SALIBAHS OR CROSS BANKS	TARRAD BASINS OR LONG. BANKS	NILE BANKS		TOTAL REPAIRS TO BANKS	REPAIRS TO CUTS	CLEARANCE OF CANALS	NEW WORKS	TOTAL CUBIC METRES	TOTAL EXPENDITURE	
			OLD	NEW						L.E.	M.
Bardis..............	59,349	38,965	193,281	..	291,595	26,570	193,589	479,121	990,875	12,497	881
Girga..............	66,178	70,645	154,732	..	291,555	33,054	264,514	245,346	834,469	9,833	869
Menshiyah..........	23,404	52,794	10,518	79,208	165,924	16,353	161,543	112,641	456,461	8,809	054
Suhag..............	25,919	33,993	10,122	..	70,034	20,382	126,513	593,483	810,412	14,162	010
Tahta..............	103,867	167,730	24,034	..	295,631	25,141	123,426	80,307	584,505	6,984	522
Tima..............	6,245	145,198	36,858	..	188,301	49,980	18,035	..	256,316	3,359	285
TOTAL.....	284,962	509,325	429,545	79,208	1,303,040	171,480	887,620	1,510,898	3,873,038	55,646	621
Kena (Farshut)......	..	..	..	..	..	..	..	430,898	430,898	5,817	122
TOTAL.....	..	..	..	..	..	..	..	1,941,196	4,303,936	61,463	943
Railway Bank.......	..	..	..	..	..	..	..	..	875,775	..	..
								TOTALS.....	5,179,711	61,463	943

N. B. — Of this sum of L.E. 61,463.943:
a sum of » 36,131.493, was charged to Corvee Relief.
and » 25,332.450, was charged to special Budget as per detail in chapter of special Budget.
The Railway Bank has cost L.E. 12,161.471 (out of which L.E. 80.388 for Balance on Asyut Earthwork Ry).
The work in Kena is on the Sharaqi Budget and is the widening of the Rashwanyah Canal.

5th Circle.

Earthwork maintenance.

105. — The programme for 1890 in the 5th Circle which extends from Assuan to the end of Markaz Farshut near Abu-Shushah was to maintain the existing works in repair and to execute as many of the ameliorations and changes as could be done by the ordinary Corvee Budget aided by L.E. 19,088.208 of the Loan money. Efforts were made but not successfully to begin work before the Council of Agriculture met by continuing the widening of Canals, as there is always a great loss of time in getting the works passed by the Council, and the delay in calling for tenders after the meeting of the Council is so great that usually the three best winter months pass by without any work being done. Experience was however gained for 1891. and in future the tenders will be called for in November and work commenced in December on the ordinary necessary routine repairs which must be done in any case, leaving the works of amelioration, such as, straightening banks, deepening and widening Canals, making new banks and minor Canals, to be discussed by the Council.

Canal Clearances 1889 & 1890.

106. — The following table shows a comparison between the clearances effected in the larger Canals taking from the Nile in 1890 and 1889 in their order on the River: —

NAME OF CANAL	WORK EXECUTED IN CUBIC METRES		DIFFERENCE IN 1890		METRE BED WIDTH	CUBIT
	1890	1889	MORE	LESS		
Ramadi	159,750	87,600	72,149	....	15	8 1/2
Killabiyah	55,651	114,095	. ..	58,444	7	10
Maallah	83,605	87,240	....	3,635	8	10
Um-Adas	11,711	20,028	....	8,327	6	11
Asfun	289,192*	149,767	139,424	....	12	8
Mahamid	....	53,726	....	....	8	9
Bayyadiyah	186,744	369,380*	....	182,636	14	9
Fadiliyah	102,678	109,613	....	5,935	11	9
Shanhuriyah	131,659	217,640*	....	85,981	15	8
Tukh	27,698	39,393	....	11,695	15	11
Ghilasi	2,485	96,391	....	83,966	12	9
Samatà	218,044*	239,552*	....	8,491	9.7.5	10
Rannan	262,255	653,400*	....	491,145	15	8 1/2
Sarf Haw	abandoned	54,915	....	54,915	7	10
Damraniyah	261,273*	101,481	159,792	....	10	10
Rashwaniyah	848	61,420	....	60,572	10	12
Hamraniyah	2,147	33,654	....	31,507	8	12
	1,826,740					

The figures marked with * include remodelling and rectification of the Canals.

The local staff which is very inexperienced in rapid work was augmented by two special survey parties who levelled the principal Canals, making out the lists of diggings and giving them to the contractors.

Owing to the absence of labour and lack of push among the subordinates, there is always a dread that the work given out will not be executed before the rise of the Nile.

Frontier Province.

107. — In the Frontier Mudiriyah, the works north of Gebel-es-Silsilah were executed as usual by the local staff under the Inspector.

In Markaz Aswân which extends from Aswan to Gebel-es-Silsilah, the Sub-Governor of Aswan, Mahir Bey, executed the work of repairs by the Shekhs on a system of measurement. With such capable direction as Mahir Bey is capable of giving, this system leads to no bad results. A high rate was allowed to give the labourers means of working to good profit.

At Wadi-Halfa, the new Deberah Canal which was partially dug in 1889 was prolonged under the superintendence of the Military Engineers to whom a special Arab Engineer was transferred from Kena.

The amount spent in 1889 was..............	L.E.	475.781
and in 1890	»	1,159.448
Making a total of 77,297 m³ for	L.E.	1,635.229

The Canal was very successful in the Nile time, as the Nile was very high.

The work done in the Kena Circle is shown hereafter. Certain details of interest are shown in the annexed tables. Thus it will be seen that the large cube of 4,374,649 m³ was executed, of which 1,826,740 are for clearing and widening large Canals, 1,894,668 for cleaning and widening small Canals (sayyalahs), and 653,241 m³ for repairs to Banks and " sadds " in Canals and cuts.

There is no doubt that the great height of the land surface compared with the level of an average flood renders the Canal clearances far the largest work in this Circle. The basins are shallow and the Bank repairs consequently small.

List showing the works of amelioration effected by the Corvee Grant aided by L. E. 19,088.208.

DISTRICT	NAME OF CANAL	CUBES	RATE	TOTAL CUBES PER DISTRICT	EXPENDITURE IN DISTRICT	
					L.E.	M.
Farshut....	Damraniyah..................	167,273	54	540,015	7,290	025
	Rannan E. (old Sarf Haw)...	157,000	»			
	Sayy. Samasmah............	45,472	»			
	Khor El-Halimi	36,395	»			
	Sayy. Kom-el-Bega..........	45,273	»			
	Sayy. Negma and branches..	23,724	»			
	Khor Abou-Ayyat............	18,340	»			
	Masraf Abou-Shusha	46,538	»			
Deshna	Rannan Canal................	170,000	54	792,372	11,321	574
	Samata do.	248,044	»			
	Marashdah Canal & junction.	258,505	»			
	Mahgar Dandarah	23,568	Piastres 4			
Kena.......	Der Canal & 2 channels.. . ..	82,621	45	214,458	3,163	382
	Dandarah Canal..............	38,618	Piastres 2 ½			
	Sayy. Tukh..................	31,748	55			
	Tukh Canal..................	61,480	51			
Qos........	Fadiliyah Canal..............	75,000	50	348,542	4,356	775
	Bayyadiyah Canal............	150,000	»			
	Shanhuriyah Canal...........	100,000	»			
	Sayy. Karnak................	23,542	»			
Isna	Asfun Canal..................	289,192	50	454,678	5,642	003
	Maallah Canal................	50,000	49			
	Killaliyah Canal..............	20,000	»			
	Sayy. Qibah syphon	50,831	»			
	Sayy. new Sahil Isna........	17,984	»			
	Sayy. Mahamid syphon......	26,671	»			
Idfu	Qandiliyah Canal.............	126,541	71	265,303	4,131	917
	Rodisiyah Canal..............	18,325	51			
	Sharawnah Sayy.	24,397	»			
	Sayy. Ramadi Sahel.........	42,292	»			
	Sayy. Rodisiyah.............	7,111	»			
	North & South Silwa.........	46,634	61			
Hudood....	Deberra Canal	77,267	60	77,267	1,159	000
			Total.........	2,692,635	37,064	676

List of earthwork executed in 1890, in the 5th Circle.

DISTRICT	SALIBAHS OR CROSS BANKS	LONGITUD. BANKS OF BASINS (TARRADS)		NILE BANKS	TOTAL REPAIRS TO BANKS	REPAIRS TO CUTS	SILT CLEARANCE	NEW WORKS	TOTAL CUBIC METRES	TOTEL EXPENDITURE	
										L.E.	M.
Aswan	..	..	..	..	..	..	67,206	..	67,206	1,008	095
Idfu	..	41,619	..	..	41,619	7,717	244,731	265,303	559,370	7,483	029
Isna	8,011	54,842	..	6,468	69,321	20,674	139,216	454,678	703,889	9,998	070
Qos	40,369	71,813	..	1,686	113,868	16,990	151,571	348,542	630,971	7,957	000
Kina	38,102	84,732	..	7,789	150,623	10,670	98,700	152,987	512,980	6,092	014
Dishna	10,774	40,895	..	21,209	72,878	29,818	201,841	792,372	996,909	15,461	946
Farshut	24,632	17,568	62,962	8,538	113,700	5,363	166,979	540,015	826,037	12,900	000
	141,888	311,469	62,962	45,690	562,009	91,232	1,090,244	2,553,897	4,297,382	60,900	208
Wadi Halfa (Deberra Canal)	..	..	..	..	..	..	..	77,267	77,267	1,159	000
TOTALS	141,888	311,469	62,962	45,690	562,009	91,232	1,090,244	2,631,164	4,374,649	62,059	208

Details of Works charged to Special Budget 1890 in the Kena Mudiriyah.

SYSTEM	MARKAZ	RATE IN PARA	M³ AMOUNT	EXPENDITURE		NAME
				L. E.	M.	
Ramadi	Idfu	71	126,544	2,246	156	Qandiliyah
Asfun	Isna	50	289,192	3,614	800	Asfun
Fadiliyah	Kena	51	61,480	831	911	Tukh
Sahil Farshut	Dishna	54	258,505	3,489	817	Marashdah
Ditto	Dishna	54	170,000	2,295	..	Rannan
Ditto	Farshut	54	46,538	628	263	Abou Shusha
Ditto	Dishna	Piastres 3 1/2	39,261	1,275	988	Dandara
Ditto	Dishna	54	248,044	3,348	594	Samata
Killabiyah	Salamiyah	49	60,000	735	..	Maallah
Ditto	Isna	49	50,831	622	679	Say.Qibah
		Totals...	1,350,385	19,808	208	

This is exclusive of L.E. 5,817.122 spent on the Rashwanîyah Canal in the Farshut Markaz directed by and paid for by Mr. Allan Joseph, Director of Works, Suhag.

CHAPTER V.

Silt in the Upper Egypt Canals.

Comparisons with previous years.

108. — As last year, careful sections were taken of the Canals of Upper Egypt which are interesting in their results confirming the theories brought forward in the Report of 1889. Comparing the years 1889 and 1890, we have the following.

The 1890 figures are the works of clearance in 1891.

Name of Canal	Year	Distances from Head												
		pics	bed width	200 M.ᵉˢ	1 kilo.	2 kilo.	3 kilo.	4 kilo.	5 kilo.	6 kilo.	7 kilo.	8 kilo.	9 kilo.	10 kilo.
Ramadi	1890	8 1/2	15	1.10	1.67	1.69	1.51	1.04	0.60	0.32	0.16	0.10	0.35	0.03
	1891	8 1/2	15	1.49	1.71	1.85	1.16	1.17	0.44	0.32	..	..	..	..
Asfun...............	1890	8	12	0.95	1.11	0.82	0.83	0.60	0.45	0.65	0.57	0.56	0.70	0.80
	1891	8	12	1.37	1.25	0.09	0.39	0.38	0.17	0.09	0.18	0.11	..	0.06
Fadiliyah...........	1890	9	11	1.14	1.30	1.29	0.96	0.50	0.35	0.22	0.36	0.26	0.50	0.28
	1891	9	11	1.75	1.52	1.72	1.38	0.73	0.23	0.42	0.47	0.22	0.48	0.24
Rannân	1890	8 1/2	15	0.78	0.75	0.33	0.60	0.15	0.84	..	..	..	..	..
	1891	8 1/2	17	1.11	0.84	0.66	0.66	0.34	0.30	0.49	0.24	0.10	..	..
Zarzuriyah.........	1890	9	18	0.68	0.19	0.30	0.11	0.03	0.13	0.49	0.32	0.53	0.52	0.49
	1891	9	18	1.11	0.09	0.10	0.10	0.10	0.20	0.10	0.25	0.04	0.07	0.57
Girgâwiyah.........	1890	9	18	0.75	0.47	0.32	0.48	0.42	0.35	0.32	0.31	0.39	0.63	0.32
	1891	9	19	0.52	0.27	0.10	0.07	0.08	0.04	0.01	0.17	0.02	0.04	0.12
Tahta	1890	8	15	0.37	0.61	0.15	0.06	0.03	0.09	0.12	0.74	0.61	0.61	0.47
	1891	8	15	2.75	1.55	0.24	*	*	*	*	0.24	0.18	0.20	0.34
Maalla	1890	10	8	0.59	0.48	0.46	0.38	0.32	0.15	0.10	0.30	0.23	0.82	0.42
	1891	9	7	0.86	0.50	0.63	0.50	0.50	0.50	0.50	0.50	0.50	0.60	0.50
Shanhuriyah.......	1890	8	15	0.43	0.35	0.13	0.14	0.11	0.14	0.08	0.10	0.03	0.07	0.67
	1891	8	15	0.46	0.15	..	0.02	0.18	0.04	0.10	0.13	..	..	..
Ghilâsi	1890	9	12	0.13	0.37	0.38	0.21	0.17	0.12	0.07	0.14	0.01	0.11	0.15
	1891	8	12	0.31	0.09	0.41	0.45	0.14	0.18	0.32	0.28	0.14	0.16	0.01
Lahâiwah..........	1890	10	9	0.80	0.90	0.51	0.23	0.24	0.20	0.37	0.15	..	..	..
	1891	10	9	1.92	0.99	0.54	0.30	0.22	0.09	0.16	0.10	0.19	0.31	0.01
Matanna	1890	9	10	0.70	0.15	0.07	0.28	0.27	0.20	0.09	0.15	0.63	0.22	0.66
	1891	9	10	1.14	..	..	..	..	..	..	..	..	..	0.30
Damrâniyah........	1890	10	10	0.87	0.68	0.45	0.15	0.11	0.04	0.11	0.18	0.13	0.29	0.03
	1891	9	16	1.35	0.53	0.28	0.20	0.22	0.23	0.32	0.49	0.25	0.19	0.01
Kasrah.............	1890	9	16	1.59	0.45	0.22	0.25	0.55	0.40	0.34	0.07	0.71	0.72	0.49
	1891	8	21	1.38	0.50	0.17	0.28	0.53	0.69	0.44	0.50	1·54	1.16	0.86

* This length is below level.

CHAPTER VI.

Mapping and Levelling.

Personnel.

109. — The mapping Department consists of the same personnel as last year, viz : —

Mr. Ravon and four Europeans and four Arabs.

The surveying is superintended by Mr. Robert who carries on the correspondence and examination of results, aided by a young European apprentice.

The surveying parties consist of: —

Mr. Zardini, Mr. Huber, surveyors, assisted by 7 Arab surveyors.

The maps traced during the year were as follows: —

108 Tracings for the Irrigation service.
184 » » Technical Branch.
45 » » Administrative Branch.
13 » » Tanzim.
350

Outturn of maps and plans.

110. — There were 49 original maps made, including reductions of older maps.

In lithography, the European maps of the Provinces of: Girga, Asyut, Kena, Isna, Beni-Suef; and in Arabic, Isna and Beni-Suef.

The only maps not printed are: Minya, Fayum, and Gizah. Minya has been put on the stone and proofsheets struck off during the year.

There were also coloured and mounted on cloth 352 examples of these maps of Upper-Egypt.

These maps are more and more appreciated every year by Tourists and others whose business takes them to Upper-Eypt. They are sold for 20 P.E. per sheet unmounted and 50 P.E. per sheet mounted and coloured. 247 were either given to the various Administrations or sold.

Investigation above Aswan.

111. — In November 1890, Mr. Willcocks accompanied by Mr. F. Roux and two Arab Engineers again went up to between Aswan and Wadi Halfah and surveyed the river and the cataracts. Their results will be noted in 1891.

Surveying in Delta.

112. — In Behera, Mr. Zardini and party continued their survey of Beherah and have produced a most beautiful map of the western part on the scale of $\frac{1}{10.000}$. Mr. Zardini's work is very superior and he infuses a like zeal and ability into his Arab assistants.

Mr. Huber was not so successful and his results have been a little disappointing. Thus, in the following table the difference in favour of Zardini is seen : —

NAME	EXPENDITURE	AREA TRIANGULATED	COST PER FEDDAN	RATE PER MONTH	COST PER FEDDAN FOR SURVEYING	TOTAL COST PER FEDDAN
	L.E.	FEDDANS	PARAS	FEDDANS		
Zardini, in Beherah...	360	190,000	7.58	17,273	12.70	20.28
Huber, in Gharbiyah...	267	100,000	10.68	12,500	22.61	32.29

The Behera survey was conducted by 5 brigades which turned out 6,333 Feddans per month.

The Gharbiyah survey was conducted by 2 brigades which turned out 3,428 Feddans per month.

The mapping and surveying Department including all "Personnel", etc., expended L.E. 2,590 242m.; of this sum, the field establishment and their expenses amounted to L.E. 1,428 642m.

CHAPTER VII.

Original Works.

Original Works definition.

113. — These works are those of a distinctly new nature and do not include repairs nor alterations. They do not include works from Special Loan Funds. Each Circle is alloted a share of the available money, but it frequently occurs that an excessive amount of repairs to be executed causes a diversion of this money to repairs.

Expenditure of 1890 and 1889.

114. — The following table shows by Circles and Divisions the amount of money spent on new works in 1890 and 1889:—

NAME	1890	1889
1st Circle	16,488	2,716
2nd do.	2,300	3,856
3rd do.	12,315	1,815
4th Circle and Fayum......	15,151	9,298
Girga Directorate..........	In Sharaqi Loan	17,899
5th Circle.................	Do.	2,916
Totals.....	46,254	39,530

The most noticeable items are: —

115. — Six masonry Heads built L.E. 2,088 spent on large road Bridges over canals. Two red water syphons for the low lands on lake Menzaleh under the Faraskur Canal. Details 1st Circle.

The Ezbet-el-Burg Canal, the continuation of the Sharkawiyah Faraskur Canal from Damietta to the Sea was dug and its land paid for.

Part payment of Sahil Canal enlargement.

Extra works in connection with the Million Works on the Rayyah Tawfiki were done amounting to L.E. 1,662.

116. — No large original works were undertaken, except a bridge on the Safti Canal near Kelline. Details 2nd Circle.

117. — In Gizah, small sluices were put in for "Nabari" or Maize cultivation during the Nile Time. Details 3rd Circle.

In Behera, two very important regulators were built in the desert basin banks. These works, though not large, were excessively costly owing to the need of well foundations. Two similar Bridges in Upper-Egypt would have cost L.E. 3,500 against L.E. 6,538 actually spent on them.

The works in connection with the rectification of the Khatatbah cost L.E. 2,086.

A sum of L.E. 1,417 was spent on two bridges under the Railway to pass increased supply from the Mahmudiyah Canal to the lands above Lake Mareotis where cultivation is rapidly extending.

Details 4th Circle.

118. — The expenditure on heads, regulators, culverts, and syphons for the Sefi Canal system again absorbed L.E. 6,392. These small works are excessively numerous and though their average cost is under L.E. 500, the total in 5 years amounts to a large sum. The larger syphons will be in future charged to the Drainage Loan.

The Abu-Bayarah Canal, a red water feeder to the Garnusi basin was commenced this year and a sum of L.E. 2,615 spent on it. The remainder will be executed in 1891 and chargeable to Sharaqi Loan.

Similarly a commencement was made of the Dalgawi Escape, a work of 15 arches to discharge the basins south of Asyut into the Bahr Yusif, L.E. 3,000 being spent for collection of materials.

The sum of L.E. 1,952 was charged to Qusheshah Escape (the large portion, L.E. 35,330 was charged to Sharaqi Loan).

In the Fayum, six heads were built to canals to better the regulation. A large sum was alloted to the Fayum, but owing to the failure of the Contractor to burn bricks, it was diverted to other works. This sum will be restored next year.

In Girga and the 5th Circle, all works of a new type are charged to the Sharaqi Loan and do not figure in the Ordinary Budget.

CHAPTER VIII.

Works for prevention of Sharaqi.

Allotments.

119. — A Loan L.E. 800,000 having been obtained, the sum of L.E. 161,009 was set aside for the works which will lead to the distribution of the Nile Flood water even in bad years.

120. — The land in Upper-Egypt is divided into systems or chains of basins distinctly separate from each other, by rocky or gravelly ridges or by large offtake Canals from the Nile.

Division into Systems.

121. — These works are grouped into 7 classes: —

Division into 7 classes of Works.

1) Works destined to carry the water of the southern system into the northern system, so as to irrigate the higher portions of the northern system and to bring the water of the southern system into the northern to make good deficiencies at the time of emptying the basins. These consist of: syphons, rock cut canals, and aqueducts.

2) Regulators at the northern end of a system to serve three purposes: —

a) To diminish the water in the system during good Nile Floods when the system is overcharged.

b) To empty the system slowly at the time of "Sarf" (emptying of the basins) and thus lead to properly arranged sowing of the seed in the soft mud.

c) To give the last basin of a chain red water direct from the Nile by opening the regulator and giving the water of the rising Nile backwards into the basin in which the Regulator is situated.

3) Regulating Bridges in the cross banks (Salibahs) of the basins to admit of the basins being kept at a uniform level in good Niles by passing water through them and in bad Niles to conserve the water by ponding it.

4) Enlarging and deepening Canals of supply.

5) Extending them through their system in the riverain lands, so that the basins of a system may each be fed by red water instead of the old practice of allowing the Canal of supply to run through the basins in succession.

6) Digging and enlarging the smaller Canals of distribution called "Sayyalahs".

7) New Banks for the division of existing basins into two.

Progress n 1889 and 1890.

122. — The progress made in 1889 and 1890 to the realization of the programme drawn out in 1888 was as follows in each system, commencing from the west side of Kena-Isna.

lamadi System.

123. — In 1889, one escape and culvert made. In 1890, one regulator half finished (Mamariyah Bridge).

The Ramadi Canal deepened to 8½ cubits Aswân in 1889 and the Qandiliyah Sayyalah deepened and widened to 9 metres bed on 10 cubits.

Asfun System.

124. — In 1889, commencement made of deepening to 8 cubits and widening to 12 metres the Asfun Canal. This work was carried on during 1890, but owing to the incapability of the Contractor due, as he says, to want of labour, this Canal was not finished in August 1890 and the final work will have to be done in 1891. The head of this Canal, a fine masonry work, was put in order in 1890.

The lower end of the Canal (formerly the Mahamid) was extended 6 kilometres.

Fadiliyah System.

125. — In 1889, the Ishara Regulator was built, and in 1890, the Dandarah Escape, the Taramsah Regulator, the Hod Taramsah Regulator were built.

In 1889, the Fadiliyah Canal was widened to 11 metres on 9 cubits: the Shaat Canal was extended 3 kilometres and the Der Canal was widened to 12 metres bed on 10 cubits by the Corvee.

In 1890, the Shaat Canal was deepened and widened to 10 cubits on 10 metres bed.

The Isharah Cross Bank was made in 1889.

Sahil Farshut System.

126. — In the Sahil Farshut system, the earthworks of 1889 were: Rannan Canal widened and deepened to 15 metres bed on 9 cubits: the Damraniyah to 10 metres bed on 10 cubits.

In 1890, the Marashdah Canal was practically entirely dug to 9 metres width on 9 cubits on a length of 17 kilometres.

The Rannan was further widened to 17 metres on 9 cubits and the Rashwaniyah spoil banks were removed in the Nile time and the lower half of this canal was deepened and widened to 12 metres on 11 cubits.

Five "Sayyalahs" were remodelled near Farshut and Bahgurah and one for the west of the Rannan Canal.

A bank to Central Dahasah was made.

In masonry works, the Rashwaniyah syphon begun in 1889 was completed in 1890: the Haw Escapes (a double work) were made out of old disused works: the Abu-Shushah Escape was made on to the Nile to drain Hod Samhud, the last basin of Kena.

Three Sayyalah Heads (Group Khor Abu Ayat) were made near Farshut to control the supply.

All these, except the lower half of the Rashwaniyah syphon, were made in 1890.

To return to the extreme south, the small isolated portions on the left between Gebel Silselah and Isna had Canals deepened and widened in 1890 to 12 cubits. These Canals are very unsatisfactory, as a low Nile can never fill them properly.

Killabiyah System.

127. — In masonry in 1889, the South Salamiyah Regulator was built and materials for the syphon Qibâh collected.

In 1890, the Qibah syphon, the north Salamiyah Regulator were built and near the latter a culvert for red water to Hod Salamiyah North.

In Earthwork in 1889, the Killabiyah Canal was deepened to 11 cubits on 7 metres bed width and the Maallah Canal to 10 cubits with a bed width of 8. Some stony portions of the Killabiyah were deepened and the Canal was extended down to the South Salamiyah Bridge.

In 1890, the Killabiyah was further deepened one cubit on the same bed width and the Maallah remained intact. A Sayyalah from the Qibah syphon was dug for 6 kilometres to bring the high level water along the Sahil.

Bayyadiyah System.

128. — The Bayyadiyah Canal in 1889 was deepened and widened to 14 metres bed on 9 pics and much straightened.

The Mahgar Huzzam was deepened and connected with the southern high parts of the system to the south (the Shanhuriyah) and the flow of water rendered more rapid. In 1890, the Sayyalah Karnak was deepened and widened in the first half of its length to 4 metres bed width on 10 cubits.

In masonry works in 1889, the Damamil (wrongly named Higazah) Regulator was built on the Higazah "Sayyalah" and the Ashshi Escape on the Nile entirely remodelled. In 1890, no masonry works were done.

Shanhuriyah System.

129. — The earthwork in this system consisted in 1889 of widening and deepening the Shanhuriyah Canal to 15 metres bed on 8 pics. In 1890, eleven kilometres were deepened from kilometre 19 to 30, and the omissions and errors in the first 19 kilometres rectified.

In masonry in 1889, nothing was done.

In 1890, the Shanhuriyah Canal Head was begun and carried to Floor level.

Ghilasi System.

130. — In earthwork in 1889, the Ghilasi Canal was deepened to 8 cubits, and the Samata Canal, a sahil Canal joining up numorous local "sayyalahs", was dug 5 metres bed width on 10 cubits.

In 1890, the Ghilasi was only cleaned and the Samata widened to 9 metres bed width at head decreasing to 7 and 5 metres and carried on to the Hamad Escape. The junction Canal Qasr, to take the southern basin water under the Tarif Canal for the Gheziret Qasr es-Salamiyah, was dug on 12 cubits and 3 metres bed.

The masonry works in this system consisted of the important Escape Hamad on to the Nile and the Regulator Hamad to the junction Qasr Canal.

To return to the West Bank of the Girga Mudiriyah.

South Suhag System.

131. — In this most extensive system, the earthwork was not prosecuted with vigour pending the construction of the necessary masonry works to control it.

In 1889, in earthwork, the Zarzuriyah Canal was widened and deepened to 16 metres bed on 9 cubits: The Um-el-Tubul to 11 metres bed on 9 cubits: The Zarzuriyah was prolonged 5 kilometres on 9 metres bed on 10 cubits, and the Girgawiyah was widened to 18 metres bed on 10 cubits.

In 1890, the Rashwaniyah, north of Kasrah syphon, was deepened and widened on 10 cubits and 7 metres bed width to the Uthmaniyah "Sayyalah".

The Zarzuriyah was deepened and widened to 18 metres bed width on 9 cubits down to its 24th kilometre, and its prolongation .deepened and widened to 9 metres on 9 cubits. The Girgawiyah Canal was deepened to 9 cubits on a width of 18 metres, and its prolongation through Hod Suhag under the Suhagiyah Canal by the syphon to join the Aulad Nusêr was carried out on a bed width of 15 metres on 9 cubits for a distance of 10 kilometres ; of these kilometres 7 were done from the Railway earthwork. The Ambariyah "Sayyalah" was deepened to 11 cubits on 5 metres bed.

In masonry in 1889, the great Suhag syphon was built up to bed level also the Kasrah syphon. Materials were collected for the Zarzuriyah syphon. The Suhag escape was partially built. The Khanansah culvert was also built for a "hoshah".

In 1890, the Kasrah, Zarzuriyah, and Suhag syphons were finished, also the Suhag escape.

The regulators Beni-Himel east and Magabrah N° 1 were built. The Abu Bakkar "Sayyalah" Head was built to deliver the Rashwaniyah water into the Beni-Himel west basin. The Bindar syphon which blew up in 1887 was rebuilt and the Bardis bridge on the Zarzuriyah Canal was widened and thrown out of gear as a regulator.

North Suhag System.

132. — In earthwork in 1889 in this system, the Tahta Canal was widened for 6 kilometres on 15 metres bed and 8 cubits

and beyond that to join the Enebis Canal at the 13th kilometre on 9 cubits and 13 metres. This work was partly in old Canals and partly wholly new. It was done by the Corvee.

In 1890, the Aulad Nusêr Canal was connected with the Girgawiyah Canal coming from the Suhag syphon and widened to 10 metres bed on 8 cubits down to the Samarnah basin. The Kilfaw Canal was connected also through the Tahta syphon under the Tahta Canal. The Beni-Hilal Canal connecting the Aulad Nusêr Canal with the Beni-Hilal water was made for 6 kilometres 6 metres bed width on 9 cubits, of this length, 5 kilometres were made from the Railway borrow pits.

The Qaw Canal taking from the Tahta Canal and irrigating the Sahil of the Nile down to Tima was dug for 10 kilometres with a bed width of 6 metres and on 9 cubits, and joined on to the old Mishta Canal which it supersedes; of this, 8 kilometres were made by the Railway earthwork. The Shaturah Canal was prolonged from the Madmar basin to the middle of Beni-Smia basin on 9 cubits and a varying bed width from 6 to 4 metres. The entire length, 9 kilometres was dug from the Railway borrow pits.

The masonry works of 1889 were building the Tahta syphon up to the arches.

In 1890, the Tahta syphon was finished and the Naga Tamam double regulator was built.

Khiyam System. 133. — In earthwork in this system, the work of 1889 was deepening the Hawis Canal to 10 cubits.

In 1890, the Tarif Canal was dug from the new Tarif Canal head on a bed width of 6 metres on 10 cubits. The Mahgar Tarif or continuation of the Tarif Canal through the rocky spur was widened and deepened. A new "Sayyalah" called the Umm-Rukhamah was widened and deepened to 4 metres bed width on 10 cubits.

In masonry, there was nothing done in 1889, save collect materials for the Tarif syphon.

In 1890, the Tarif syphon and Canal head was built.

Akhmin System.

134. — The earthwork in this system was in 1889, the deepening of the Lahaïwah Canal through a long sand and gravel ridge to 10 cubits and widening it to 9 metres bed.

The Isawiyah Canal was deepened to 10 cubits on a width of 10 metres, the height of the old syphon in the 3rd kilometre preventing any further deepening. The Canal was also diverted on to the Sahil and carried along the Sahil to the extremity of the system on a bed width of 5 metres on 9 cubits.

In 1890, the Lahaiwah Canal was prolonged some kilometres and two "Sayyalahs" made to distribute the water in the Akhmim basin.

The Isawiyah Canal was widened to 7 metres bed on 9 cubits from the 12th to the 19th kilometre and below that to 8 metres bed on 8 cubits to make up banks. The Canal was also extended to Gebel-el-Haridi to fill the rock cut Canal that was dug through the hill on a width of 7 metres at a cost of L.E. 6,910. This cutting was done by Messrs Dela Fite and Co. The Contractors attacked the rock with great vigour and displaced, partly by blasting the rock to the average depth of 3 metres on a length of 2,500 metres. Great credit is due to them for their push and energy. The rock cut Canal was joined up to the Khizndariyah old head, and now we have a clear run from the Isawiyah head along the Sahil for 43 kilometres to the Nawawrah syphon.

In masonry in 1889, there was nothing done.

In 1890, the Gallawiyah escape, a combined work of 3 Regulators, was built at the outlet of the system to prevent flooding on the rock cut Canal.

Khizndariyah System.

135. — This system is the first in the Asyut Mudiriyah. The works have been delayed in this system and in the next owing to the necessity not being so pressing.

In 1889, nothing was done, save to collect materials for the Nawawrah syphon.

In 1890, the Khizndariyah Canal was deepened and widened to 12 metres bed on 9 cubits, but this was not fully executed.

The Dêbis "Sayyalah" was dug in Nawawrah basin to bring the water on from Gebel-el-Haridi.

The masonry consisted of the Nawawrah syphon which was completed.

Abnub System.

136. — The earthwork in this system in 1889, consisted of the deepening the Mâannah Canal to 9 cubits on 10 metres width.

In 1890, no works of an anti-sharaqi type were undertaken, save clearing out the gravelly Canal between the Khizndariyah and Abnub systems.

This ends the detail of the works to prevent Sharaqi in Isna, Kena, Girga, and Asyut. North of this chain of provinces, the Ibrahimiyah Canal commences, and owing to the long series of basins, there is not much danger of Sharaqi, save in very isolated spots.

The basins between the Sefi tracts and the hill are however deprived of red water, and it has been thought advisable to charge to the Loan the cost of making the red water Canal, the Abu Baqara, in the province of Minya.

There was no expenditure in 1889 and in 1890, from the loan money.

CHAPTER IX.

Special Budget Expenditure.

Expenditure out of the Loan.

137. — On the Loan of L.E. 800,000, the following has been spent.

L.E.	149,535.155,	Masonry Works Sharaqi.
»	54,016.538,	Earthwork Do.
»	38,879.000,	Drainage.
»	132,747.707,	Works in connection with the Million.
»	39,712.000,	Rayyah Beherah.
L.E.	414,890.400,	TOTAL.

Sharaqi Masonry.

138. — The Masonry of the Sharaqi Works is given in detail in the following table.

Establishment.

139. — Mr. Allan F. Joseph directed the principal ones in North Kena and Girga. He was assisted by MM. Kuhlenthal, A. Sacks, and M. Stent, who did well.

Nature of Works.

140. — The works were built with great precision and in a remarkably workmanlike manner. The whole of the skilled labor come from Cairo, but it is to be hoped that the years work will have taught the Upper-Egypt mason something in the art of masonry. His face work in mosques, etc., is very neat, but his walls and floors in hydraulic works bad, and it was found nearly impossible to employ him, although the pay was 50 °/₀ lower than the Cairo mason. Upper-Egypt is also very backward in quarrying stone.

List of Works executed in the 5th Circle, chargeable to Sharaqi Loan 1890.

SYSTEM	NAME OF WORK	BRICKWORK		CONCRETE		ASHLAR		PITCHING		PUMPING	PLASTERING		COST
Killabiyah....	Qibah Syphon	942	0.900	303	0.050	..	..	283	0.430	200	85	0.12	1,640.428
do. ..	Salamiyah Bahari Escape.	287	1.000	118	0.900	5.14	4.000	143	0.500	..	..	..	306.520
do. ..	Salamiyah Bahari culvert	116	1.000	48	0.900	1.74	4.000	19	0.500	..	..	..	188.497
Shanhuriyah..	Shanhuriyah head......	263	1.000	437	1.000	..	..	..	..	..	..	..	700.000
Ramadi.......	Mâamariyah Bridge.....	192	1.000	303	0.900	..	..	..	..	..	..	..	300.600
Fadiliyah.....	Taramsah and Dandara..	1,197	0.900	478	0.930	25.69	3.600	433	0.390	..	223	0.12	1,988.099
	Total.........	3,000		1,707		32.57		878		200	308		5,523.544

Drainage Works.

141. — The Loan of 1890 for L.E. 800,000 rendered it possible to push forward the drainage system of the Ibrahimiyah Canal and the Delta.

In the Delta, L.E. 10,395 were spent in dredging the inlet into Lake Menzalah. A special dredger was got out for this wild-out-of-the-way spot and it has cleared a deep channel for the outlet of the drainage to the North East of Mansourah. The outfall is much improved. The actual work done in 1890 was: —

1) Dredging in Lake Manzaleh.	=	$259,874$ m³	L.E. 10,395
2) Umum-el-Behera drain.....	=	300,987 »	» 7,149
3) Bahr-el-Bagar drain........	=	110,190 »	» 3,151
TOTAL......		873,276 m³	L.E. 20,695

List of works executed in the Girga Directorate chargeable to Sharaqi Loan in 1890.

SYSTEM	NAME	BRICKWORK IN CEMENT		BRICKWORK ORDINARY		CONCRETE		ASHLAR		PITCHING		RUBBLE MASONRY		PUMPING		TOTAL
		M³	L. M.	M³	L. M.	M³	L. M.	M³	L. M.	M³	L. M.	M³	L. M.	L.E.	M/M	L.E. M/M
Ghilasi *	Hamad Bridge	..	..	415	1.000	275	0.100	11.70	4.000	80	0.150	..	..	..	..	851.058
	Hamad Escape	..	..	1,278	1.000	813	0.100	41.50	4.000	240	0.150	..	..	..	..	2,701.230
Khiyam	Tarif syphon	33	1.100	2,310	1.000	536	0.100	49.18	4.500	753	0.380	..	..	450	000	4,934.161
Akhmim	Gallawiyah Works	..	..	1,973	1.000	988	0.100	26.35	4.500	536	0.350	..	..	..	..	3,812.980
	Gebel-Haridi Ch.	..	..	1	..	..	..	..	..	..	..	..	..	..	..	6,910.000
Khizndariyah	Nawawrah syphon	72	2.200	4	2.200	1,079	1.050	94.95	5.000	995	0.450	2.60	0.950	943	000	10,225.719
Sahil Farshut *	Haw Bridges	41	1.000	1,064	1.000	182	1.000	17.82	3.500	540	0.380	..	..	..	..	2,301.444
	Kom-el-Bega Bridge	..	..	199	1.000	198	1.000	4.75	4.500	145	0.350	..	.	..	..	402.805
	Khor Abu Ayat Bridge	..	..	138	1.000	82	1.000	2.66	4.500	81	0.150	..	..	..	..	281.360
	Rashwaniyah syphon	123	1.100	3,868	1.000	981	1.000	109.47	4.500	1,129	0.380	143.—	1.150	774	500	10,078.860
	Abu-Shusha Escape	106	2.00	1,345	1.000	983	1.000	50.63	4.000	417	0.450	..	..	..	..	3,235.648
South Suhag	Abu-Baqqar Bridge	6	2.00	227	1.000	79	1.000	3.15	4.000	132	0.450	..	..	..	..	421.957
	Kasrah syphon	65	2.000	4,883	1.000	1,447	1.150	141.65	5.000	1,404	0.550	177.—	1.000	1,500	000	13,790.341
	Beni-Himel E. Bridge	22	2.000	390	1.000	196	1.000	8.11	4.000	171	0.450	..	..	..	..	856.816
	Zarzuriyah syphon	75	2.000	3,479	1.100	1,266	1.050	105.16	5.000	789	0.450	..	..	1,464	551	11,364.927
	Bardis syphon	..	..	121	1.200	..	..	19.00	2.400	..	..	..	..	..	..	304.000
	Bindar syphon	..	..	128	1.000	105	1.000	..	..	..	..	..	..	..	..	273.200
	Magabrah Bridge	..	..	850	0.910	376	0.890	88.50	3.990	522	0.390	..	..	150	000	2,043.312
	Suhag Escape	..	..	2,112	0.900	1,036	0.920	288.21	4.000	1,692	0.450	..	..	..	..	5,670.344
North Suhag	Suhagiyah syphon	4	2.000	10,581	0.900	2,593	0.920	56.90	4.000	3,728	0.450	..	..	900	000	17,305.155
	Tahta syphon	11	2.000	1,748	0.900	453	0.920	8.26	4.000	516	0.450	..	..	300	000	3,220.105
	Naga Tamam	6	2.000	480	0.950	306	0.950	12.22	4.000	298	0.450	..	..	..	..	1,120.190

The works marked * are in the Kena Mudiriyah.

The sum of L.E. 7,149 was spent in deepening the drain running into this part of Manzaleh called the Masraf Umum-el-Beherah. The lower and middle reaches were widened and deepened. The Daira Saniah Lands will profit much by this.

L.E. 3,151 were spent in dredging the Bahr-el-Bagar, the southern drain of the Province of Sharkiyah. The work done has only been partial, owing to the slowness of the dredging. It is hoped that this work may be finished in 1891.

1st Circle.

142. — The total of the expenditure in the 1st Circle was L.E. 20,695 representing a cube of 873,276 m³.

2nd Circle.

143. — In the 2nd Circle, the drain N° 1 draining between the Damietta branch of the Nile and the Bahr Shibin was graded throughout and the project prepared. The work was only partially executed in 1890 by an expenditure of L.E. 6,239 representing a cube of 249,560 m³ at L.E. 0. 025mill.

The expenditure of the Circle is brought up to L.E. 6,907 by an expenditure of L.E. 667 on iron pipes for syphon passages for irrigation water.

3rd Circle.

144. — In the 3rd Circle, the project of the Edku drain was elaborated. This drain will drain the triangle between the Railway, the Nile, and the Mahmudiyah Canal into Lake Edku. A syphon was made under the Mahmudiyah Canal out of the Million Loan. The lower half of the drain was executed in 1890 at a cost of L.E 4,277. This sum includes 250,000 m³ on earthwork costing L.E. 3,996 and L.E. 94 on syphons. The balance on petty establishment.

4th Circle.

145. — In Minya and Beni-Suef, the sums of L.E. 5,658 and L.E. 1,342 respectively were spent in deepening the Muhit drain. There was no special project got up, as these projects have been now waiting for several years for want of money. This sum of L.E. 7,000 represents 514,741 m³ of work.

The drainage projects have not made much progress owing to the difficulty in arranging for the surveys and the slowness of dredging operations when the projects are sanctioned. The lines are all well determined, but progress is slow. The only time for work without dredging is from March to August.

The following is a list of expenditure on Drainage Works in each of the four Circles of Irrigation: —

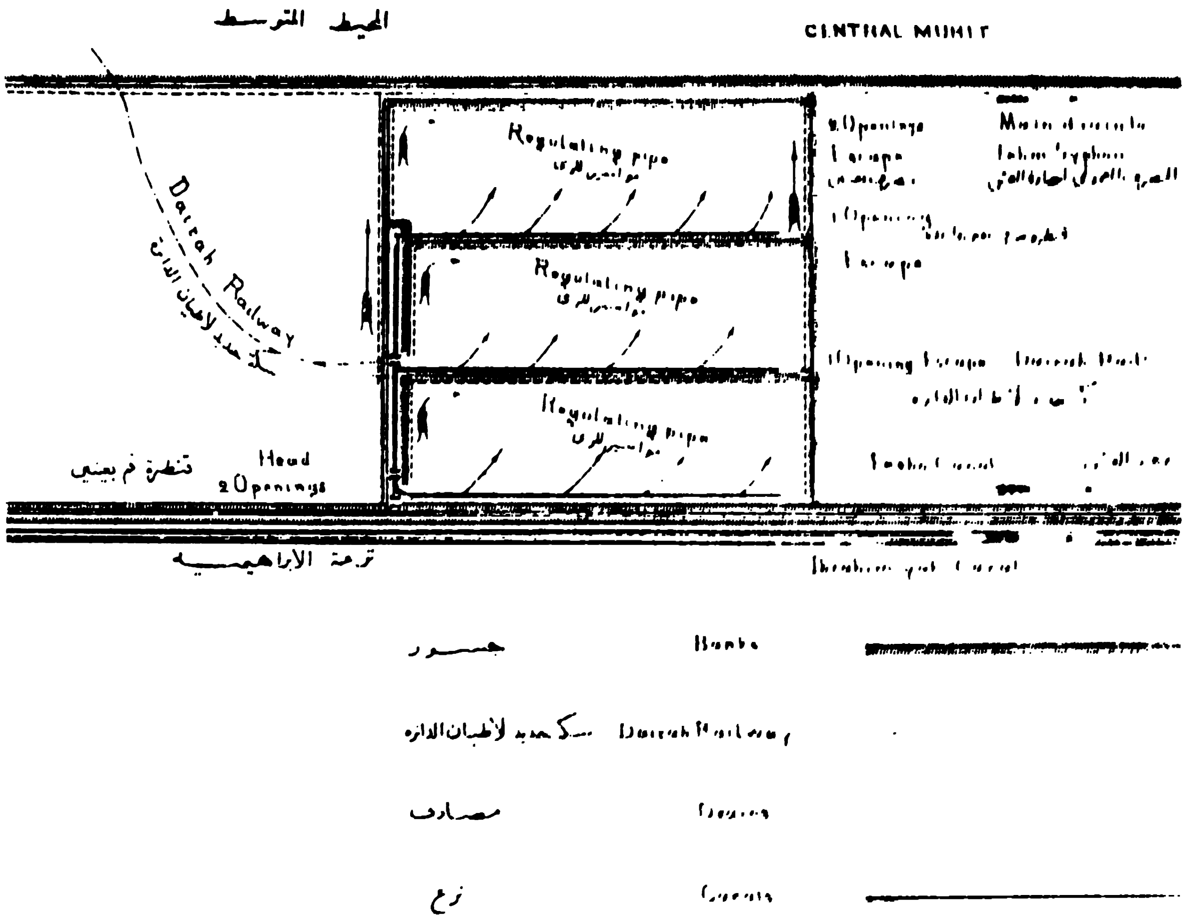
PROVINCE	NAME	COST	TOTAL
Dakahliyah............	Dredging Manzalâh Lake..............	10,395	
do.	Widening & deepening Bahr El Bakar drain .	3,152	
do.	do. deepening Umum El Behera drain.	7,148	
			20,695
Gharbiyah............	Remodelling drain N° 1.................	6,028	
do.	Shubrababel drain N° 1.................	211	
do.	Metal pipes for drain N° 5..............	667	
			6,907
Behera	Edku drain	4,277	
			4,277
Beni-Suef............	Muhit of that province..................	1,342	
			1,342
Minya	Muhit of that province..................	5,658	
			5,658
		Total L.E.......	38,879

Rayyah Behera. 146. — A grant of L.E. 45,000 was made for deepening this Rayyah. This money has been spent in addition to the Ordinary Budget. The aid was most satisfactory, as it enabled the Rayyah to be opened in April reducing the cost of pumping in 1890 by about L.E. 12,500, and it will enable us to dispense altogether with pumping in 1891. This will save about L.E. 34,000 in 1891. The return on the money is remarkably rapid!

CHAPTER X.

Drainage and Reclamation.

Progress and results of drainage. 147. — The Drainage of the low lands in the Delta has been pushed on in the last 3 years as far as possible by Ordinary Funds

البحر المتوسط
CENTRAL MUHIT
Regulating pipe
مواسير الري
Regulating pipe
مواسير الري
Regulating pipe
مواسير الري
Darrah Railway
Head
2 Openings
قنطرة فم بعيني
ترعة الابراهيمية
Ibrahimiya Canal
2 Openings
Escape
1 Opening
Escape
1 Opening Escape
Banks
جسور
Darrah Railway
سكة حديد لأطيان الدائرة
Drains
مصارف
Canals
ترع

and undoubtedly much good has been done. The financial results are still quite obscure, as in the Revenue Department the only practical test of results is decrease of arrears of rent. If a drain benefits a man's land and the tax is low, the owner gets all the profit and the Government nothing, unless the owner has arrears of rent against his name. In the case of abandoned Lands, the Government rents them, but its agents never can say to what cause they can refer the amelioration or even give an idea on what drain they are situated. It has been found impossible to get satisfactory statistics in time for this Report, but efforts will be made during the year 1891 to get reliable statistics out of the Finance Ministry.

Notable points in reclamation.

148. — The most notable points to which attention may be directed are: —

1) Reclamation of the Salaqus lands by the Dairah Saniah.
2) Drainage in the Fayum.
3) Colmatage at Tamai by the State Domains.
4) Amelioration of Markaz Arm in the Province of Sharkiyah.
5) Colmatage at Bassendilah in the Province of Gharbiyah undertaken by Mr. Willcocks for the Daira Saniah.
6) Drainage reclamation on the Masraf Umum-el-Behera and consequent extensive increase of cultivated area.

A few fragmentory notes are adjoined when possible on these 6 localities.

Salaqus Reclamation.

149. — On the Reclamation of Salaqus Lands, Major Brown writes as follows: —

The Dairah Sanieh made a grant of L.E. 1,100 for carrying out an experiment to test the value of my proposals for the reclamation of the Salaqus lands.

The area included in the experiment is 738 feddans. The sketch map opposite will best explain in what the works consist in principle.

The 738 feddans are divided into 3 "Hoshahs" and the head on the Feshn Canal and the escapes are designed to be suitable to the following programme.

The head is opened and water allowed to flow into the Hoshahs in such a way that they may each fill at the same rate, this result being secured by the iron pipes in the channel, the discharges through which are regulated by vertical stakes driven in front of the pipes as required. While the "Hoshahs" are filling the escapes are kept closed; when the Hoshahs are full, the escapes are opened to such an extent as to keep the water at the level which fully floods the Hoshahs. Lastly the head is closed and the Hoshahs emptied and allowed to dry.

The time of each operation is: —

7 days to fill
7 days to flow
7 days to empty
7 days to dry.

This series is begun in November and repeated until at last the end of February probably later. At any rate, three washings can be given during the winter. During the following floods, red water will be passed over the land, and after the water runs off, "Barsim" and beans will be planted. If "Barsim" is planted the washing can go on while "the Barsim" is on the ground.

This is a process of surface washing, in which the salts brought to the surface are dissolved and carried away in the water. It is therefore best not to be too sanguine about the results, as those who have experience cast discredit on this method and prophecy failure. They say that salts must be forced downwards into deep drains, and not drawn upwards. I believe the experience of Abuqir Lake reclamation teaches this also. Nevertheless it is well to give this surface washing system a trial before resorting to the expense and loss of land in providing sufficient deep drains to work the more approved system, as the salaqus lands are not saturated with salts to the same extent and depth as the Abouqir lake lands, and the less expensive method may succeed, and if does not succeed, it can always be converted into the other method by adding more drains without losing any of the benefit of the expenditure already incurred. The cost of the masonry works Canal, and drains on the 788 feddans treated was at the rate of L.E. 1 ¼ a feddan. The Contractor who made the culverts and banks, has offered (so he tells me) to rent the whole of the 788 feddans from the Dairah in 1892 at L.E. 2 a feddan. He, at any rate, has confidence that the operations will succeed.

[illegible] foreshore.

150. — The reduction of the level of the Birket-el-Qurun has been going on steadily ever since the Hod El Tayur Basin was made "Seifi", i. e. since the practice of filling the basin in the Nile time was abandoned. In former Reports, the area of the dried foreshore was estimated at 10,000 Feddans. It has been found impossible to get out of the Mudiriyah and Dairah Sanieh officials, statistics of the land reclaimed or rented which was formerly marsh.

Major Brown has recently induced the Mudir to erect stone pillars to mark limits and by them the water's edge can be more accurately delimited.

The other drainage near Bedah and Tamiyah appears to have produced no result [illegible]

In the Tamai Taftish (11,897 feddans; value L.E. 181,535), the following statistics are given to show the conditions of the colmatage operations : —

NAME	YEARS			
	1887	1888	1889	1890
Length of private Canals, in Kilometres........	18	24	28 ½	29 ½
Public Canals passing the estate	43 Kilometres			
Length of private drains, Kilometres...........	5	10 ½	16	19
Public drain (Tamai and Nizam)	13 Kilometres			
Length of Roads, in Kilometres	42 ½	42 ½	47	50
Area warped each year, Feddans...............	1,323	1,866	2,768	2,861
Coal expended, in Kantars.....................	3,142	4,925	6,022	2,717 ½
Cost, in piastres	17,050	36,703	35,119	16,944
Expenditure on Canals and Drains......Piastres	25,160	29,997	37,813	25,303
Expenditure on Roads (conservation and maintenance)...................... .....Piastres	15,546	2,977	5,459	3,042
No. of Engines for lifting water................	15	16	16	14
Indicated total HP..............................	159	199	199	177

Of the total area, there were rented in 1890, 4,995 Feddans.

The crops during 1890 cultivated directly by the Domains were : —

Cotton..............	1,195	Feddans.
Barley..............	1,133	»
Beans....	300	»
Clover..............	2,030	»
Wheat.........	836	»

I may add that Mr. Garstin helped the Domains much by clearing the Government Canals, to carry the larger amount of water required for the colmatage operations.

CHAPTER XI.

Navigation.

Extent of navigable lines.

152. — The navigation in Egypt is confined to certain trunk lines in the Delta, viz: —

Central Delta.

The Barrage to Mehallet Kebir by the Bahr Shebin.

The Barrage to Kafr-Zayyat and thence to Kuddaba Lock into the Nile by the Baguriyah.

Eastern Delta.

The Nile to Ismailiyah and Suez by the Ismailiyah Canal and its branches and to Zagazig by the Wadi Canal.

The Barrage to Mansurah by the Rayyah Taufiqi, thence by the lock to the river or on to Manzaleh by the Bahr Saghîr.

The Barrage to Zagazig by the Rayyah Taufiki and Bahr Muez.

Western Delta.

In Beherah, the Mahmudiyah Canal is the navigable line between the Nile and Alexandria.

Tolls.

153. — Navigation in Egypt is much hampered by tolls in the Delta and because the thorough lines are not yet in full working order. The number of boats passing through the Atfeh Lock at the head of the Mahmudiyah Canal has much diminished of late years owing to the water being stopped at the Barrage. The following table shows this: —

SEASON	Nº OF BOATS ENTERING AND LEAVING CANAL	ARDEBS	BOATS PER DIEM	ARDEB PER DIEM
1884 - 1885	10,198	2,058,939	27.9	202
1885 - 1886	8,760	1,811,918	24.0	206
1886 - 1887	8,662	1,696,200	23.7	196
1887 - 1888	5,955	1,037,676	16.3	174
1888 - 1889	4,964	860,688	13.6	173
1889 - 1890	5,532	1,046,168	18.5	189

Accidents to Locks.

154. — The year 1890 has been a very disastrous year to the masonry works.

The Shubrah Lock Ismailiyah Canal, after having stood well for 18 years, suddenly cracked and the right downstream wall fell forward in such a way that the lower gate became immoveable. It has been recently laid dry and the fact has been discovered that though the parts above the floor are made of extremely hard well set stone masonry in cement, the foundations are exceedingly bad. The concrete has been thrown in any how and is much mixted with sand showing probably that the springs were not sufficiently kept down.

The Siryakos Lock shows signs of yielding. This is at kilometre 18 of the Ismailiyah Canal.

The Bahr Saidi Lock built in 1887-88 has also cracked, but not in a way to hinder its working.

Illegitimate tolls.

155. — There can be no doubt that at the locks, tolls of a piastre or two are levied on all boats and perhaps even more. It is incumbent on the Inspectors to try and put a stop to this. Perhaps the illegitimate fees are trifling, but a little thing like this taken at every lock will soon stop navigation.

To avoid a very small lock due, the natives carry their goods round the Locks by carts.

CHAPTER XII.

Crops.

Collection of statistics.

156. — Up to the present, we have not succeeded in obtaining any reliable statistic about the actual area of crops cultivated. The Finance Ministry sent round to the Irrigation Department the names of a number of selected villages. A small slip was furnished to the District Engineers and others who were requested to investigate the areas of the various crops grown in the course of the year. The result has not yet been disclosed.

Mr. Willcocks investigations.

157. — Mr. Willcocks himself at the same time put in hand the investigation of the cropped area. His measurers were the surveyors of contracts aided by apprentice Engineers. He checked 80,334 Feddans in Menufiyah out of a total of 340,000 Feddans with the following result in the Flood season :—

Crops sown in Summer...........	36	per cent.
» » » Nile Time...........	57	»
Uncultivated, i. e. Fallow..........	7	»

This shows that in the Nile time practically, the whole area is under cultivation. The winter measurements of winter 1890-91 are not yet complete.

The Province of Menufiyah may be considered as essentially cultivated by small tenants. The southern districts of Gharbiyah on the other hand are more in the hands of large proprietors. Here the proportions are changed. They are :—

Crops sown in Summer.............	44	per cent
» » Nile Time...........	39	»
Uncultivated or Fallow.............	12	»

In the Northern districts of Gharbiyah in the poor lands bordering the Lake where, owing to failure of supply combined with a falling market, rice cultivation has largely decreased, the summer sown crop is cotton principally. The " dura " (maize) does not produce much. The cotton is from 69 to 72 per cent of the cultivated area. This state of affairs cannot of course last, as the land is poor and will not stand incessant cropping with cotton, but as the excess of cotton results from the forced abandonment of rice owing to failure in summer supply, we may hope that by the time, they have thoroughly worn out their land, the cultivators will be able to return to rice, owing to an increase of supply in summer.

The gradual increase of area under summer crop in the higher lands and the non expansion of the water supply makes the prospect of the lower lands most gloomy. There is only one bright side to the question. Cotton in the law lands requires much less water than cotton in the higher lands, and thus a very little water goes a long way.

Outturn of cotton.

158. — The outturn of cotton in Egypt as known by the exports merchants show that the cotton crop was the largest on record and is estimated at 4,100,000 kantars. An increase of 900,000 kantars over last year. This result is due to the better outturn per feddan and to the excellent way in which the water was distributed.

Major Brown's note on the outturn of the Ibrahimiyah.

159. — Major R. H. Brown has furnished the following interesting note on the crops in the Ibrahimiyah Canal and its branches.

The figures in the table below give the quantity of cane brought to the 6 Daira Sanieh Factories in the 4th Circle and the total Sugar produced in kilogrammes :—

FACTORY SEASON	FROM CANE OF	QUANTITY OF CANE WORKED KILOGRAMMES	TOTAL SUGAR PRODUCED KILOGRAMMES	REMARKS
1880	1879	378,127,480	27,253,035	
1881	1880	106,453,890	8,194,320	
1882	1881	330,128,647	27,145,125	
1883	1882	219,604,230	18,038,022	
1884	1883	380,036,128	30,035,298	
1885	1884	447,659,076	58,469,770	Very high summer level in Nile.
1886	1885	506,612,565	43,807,500	
1887	1886	494,380,080	42,046,920	
1888	1887	468,524,794	43,259,968	
• 1889	1888	377,227,665	35,572,365	
• 1890	1889	342,103,590	31,314,150	Very low summer Nile.
• 1891	1890	500,885,955	52,128,703	do. do. do.

• From figures furnisehd by Ventre Bey in Qantars, kilogrammes being obtained by multiplying Qantars by 45.

The Total Sugar produced in 1890 is calculated by proportion from N° 1 Sugar produced (907.397 Quantars)

COMPARISON OF FACTORIES	CANE CRUSHED. QANTARS				SUGAR N° 1 QANTARS			
	1888	1889	1890	1891	1888	1889	1890	1891
Biba.........	1,524,426	1,250,763	1,280,245	1,860,991	105,813	82,280	88,782	147,042
Maghaghah..	2,220,973	1,455,750	1,108,354	2,041,895	151,303	104,792	75,388	154,309
Mataï........	1,870,513	1,144,968	945,471	1,828,057	134,113	79,366	64,670	158,728
Minyâ	2,279,773	1,723,024	1,665,409	2,148,910	156,949	126,280	130,248	184,601
Abû Qurqas.	1,053,277	1,217,716	1,194,337	1,450,780	75,265	91,764	84,120	117,142
Rodah.......	1,515,838	1,590,616	1,408,486	1,800,166	110,248	118,921	101,873	145,575
	10,464,800	8,382,837	7,602,302	11,130,799	733,691	603,403	545,081	908,397
Price at which sold P.E.......								60 to 63½

N.B. - The years given are those of the *Factory* Season, but the figures give the result of the *Crop* of the year before.

Table of Cane received by and Sugar outturned by the Damaris Factory of the Daira of the late Sultan Pasha.

YEAR FACTORY SEASON	SUGAR CANE CRUSHED	SUGAR No 1.	SUGAR No 2.	SUGAR No 3.	TOTAL
	QANTARS	QANTARS	QANTARS	QANTARS	QANTARS
1884	258,855	17,201	4,549	1,449	23,199
1885	258,406	17,356	5,015	2,349	24,720
1886	250,426	16,920	5,062	1,723	23,705
1887	272,984	16,872	5,141	1,890	23,903
1888	274,549	17,590	4,606	1,440	23,636
1889	276,505	18,477	4,819	1,352	24,648
1890	266,218	18,047	4,701	1,035	23,783
1891	328,421	23,951	not yet outturned		

An examination of the foregoing tables will show that in spite of the prolonged low level of the Nile in the summer of 1890, the sugar cane crop was the best on record as regards the sugar made both in the Daira Sanieh Factories, and in sultan Pasha's Factory at Damaris. In the Factory season of 1886, a slightly greater quantity of cane was brought to the Daira Sanieh Factories, but the sugar made from it was 20 per cent less than that made from the crops of 1890.

There can be no better proof of the successful working of the rotation than these returns.

The early planting of cane has had, I beleive, a good effect, in as much as the cane was ripe when brought to the Factory, but I beleive also that the manufacture of the sugar in the Factories is better understood than it used to be, and better results are obtained. In 1886, 506,612,565 kilogs of cane produced 43,807,500 kilogs of sugar. In 1891, 500,885,955 kilogs of cane will give (judging from the quantity of No. 1 sugar produced) 52,128,703 kilogs of sugar.

2. I have been given the following figures, showing what good land properly worked will produce, and these figures may be relied upon, as I have them first hand from the land and crop owners.

Thirty feddans near the old Mudiriyah buildings in Minyà on the south east of the town gave the following outturn and profit per Feddan.

Produce 880 Qantars at 3 P.E. a Qantar			= P.E. 2,640
Expenses : —			
Seed Cane	P.E.	240	
Preparation of ground	»	120	
Cultivation and Irrigation	»	170	
Cutting and Carriage to Factory, etc.	»	150	
Total	P.E.	680	
Managers share of profit ¼ (P.E. 2,640-680)	»	490	
Land tax at P.E. 330 a Feddan	»	330	
Total expenditure			» 1,500
Balance nett profit to owner per Feddan			P.E. 1,140

This is a fine profit to make, notwithstanding the exceptionally high rate of land tax, viz: 330 P.E. a Feddan.

Besides the profit to the owner of L.E. 11.400 a Feddan, the manager also gets a high commission at the rate of L.E. 4.900 per Feddan.

3. The manager of Sultan Pasha's estate has obligingly given me the following figures.

The manager's own lands gave 220,000 Qantars from 400 Feddans planted with sugar cane. This gives a rate of 550 Qantars a Feddan.

Sultan Pacha's lands gave 402,376 Qantars from 689 Feddans, that is at the rate of 584 Qantars each Feddan.

These lands are of better quality than the average, and an unusual amount of attention is paid to their proper forming. Such good results are not generally obtained, and certainly the Daira Sanieh is not so successful.

Fayum statistics.

Halton Pasha, President of Railway Board, has been most obliging in giving me possession of the following statistics obtained from Medinah station in the Fayûm.

A certain quantity of cotton is boated on the Bahr Yûsef and sent off by Canal to Beni Suef, but I have not been able to ascertain quantities. Nevertheless the Railway return ought to be an index of the good and bad seasons in the Fayûm, and I therefore give the figures as under.

From a study of the monthly returns sent me, I have come to this conclusion that the cotton sent from the Fayûm from the 1st July of one year to the 30th June of the next year belongs to one crop, and that the cereals sent between the 1st November of one year to 31st October of the next belong also to the one crop raised during *Nili* and after *Shitwi* one and the same flood.

I cannot separate the cereals into *Nili* and *Shitwi*.

Sent by Railway from Fayûm between 1st July of one year and 30th June of next.

	CROP OF SUMMER OF YEAR							
	1883	1884	1885	1886	1887	1888	1889	1890
	QANTARS	QANTARS	QANTARS	QANTARS	QANTARS	QANTARS	QANTARS	QANTARS
Cotton...............	52,197	68,859	59,538	56,680	60,869	88,620	34,839	72,170 •
Cotton seed..........	45,131	94,424	102,664	71,829	131,157	100,284	47,853	92,093 •
Nature of summer supply	Unknown	Very good	Bad	Good	Very good	Good	Very bad	Very bad

• Up to end of March 1891.

Probably there remained but little cotton in the Fayûm at the end of March. Probably the total up to end of June will be about 72,500 Qantars.

Allowing that 2,500 Qantars found its way out of the Fayûm otherwise than by Railway, the total produce becomes 25,000 Qantars, and if it is true that 42,750 feddans were planted cotton, this gives a crop at the rate of 1 $^{3}/_{4}$ Qantars a feddan, a low figure, as it seems to me, to be satisfied with.

And the Fayûmis have expressed themselves satisfied. There is much poor and low-rented land in the Fayûm, which may be the explanation of this. The weather has a great deal to do with the cotton crop, and 1890 was favourable in its weather. But the summer supply of water was very short, so that it is a matter for congratulation that the figures compare by no means unfavourably with previous years. But the cereal crop in the Fayûm, as elsewhere in Egypt, this winter (1891), is what shows the abundance of the *Nili* and *Shitwi* crop of 1890-91.

The year for the dispatch of cereals, as I stated above, begins on the 1st November according to my reckoning. I am therefore only able to make comparisons between the corresponding 5 months, commencing with November 1st of each year.

Cereals dispatched by Railway from the Fayûm from 1st November of one year to the 31st March of the next year are: —

1st November	1883	to 31st March	1884	Qantars	268,217
»	1884	»	1885	»	149,770
»	1885	»	1886	»	132,369
»	1886	»	1887	»	125,885
»	1887	»	1888	»	181,064
»	1888	»	1889	»	85,326
»	1889	»	1890	»	129,457
»	1890	»	1891	»	312,828

The *Nili* and winter crop of 1890-91 therefore promises to be the largest at any rate since 1882.

As a record for future comparisons, I give the totals of past cereals crops below.

Cereals sent by Railway from Fayûm are: —

Between 1st November	1883	and 31st October	1884	Qantars	635,696
»	1884	»	1885	»	391,970
»	1885	»	1886	»	358,131
»	1886	»	1887	»	363,294
»	1887	»	1888	»	375,832
»	1888	»	1889	»	248,613
»	1889	»	1890	»	414,953

I have been unable as yet to get any thing reliable about the cotton crop of Asyût, Minyà, and Beni Süef, nor any information that can be trusted as regards the area planted.

I think it probable that the unfavourable season of 1889 would have had the effect of diminishing the area planted cotton in 1890, but I have no means of finding out if it was so or not. I have called for some returns, but have not got them yet.

4. I have omitted to remark on the Daira Sugar Factory figures that the low figure of 1890 (crop of 1889) is to some, if not to a great extent, due to the fact that a less area was planted with cane in consequence of the

old leases having run out, and the new ones not having been fully entered upon. The Daira Sanieh Administration could probably explain this. Possibly I am not correctly informed, but if I am, the short crop of sugar cane of the summer of 1889 must not be put down to the short comings of the water-supply, but to defects in the Administration of the Estate.

CHAPTER XIII.

Agricultural Roads.

Agricultural Roads, Maintenance, etc.

160. — The agricultural Roads have made great progress during the year. Those of the 1st Circle were completed and were largely used in the cotton season. There can be no doubt that the earthen road poor, though it be as means of transport when compared with a good metalled road is an enormous improvement on the old system of camel and donkey transport. The question of maintenance will shortly have to be solved. The wear and tear is very considerable and a sum must be allotted in the Regular Budget to cover this and a sub-head for Roads inserted in the lists of expenditure.

Plans prepared during 1890

161. — During the year, the plans and estimates for roads were prepared in Behera, Minya, Beni-Suef, Fayum, and Kaliubiyah. The Menutiyah Shekhs counselled by Mr. W. Willcocks have agreed not to have roads as the two large canals which traverse their Province and the smaller branch one give exceptional facilities for navigation. Mr. Willcocks has included in the estimates to 1891, a considerable sum chargeable to the ordinary Repair Budget for giving free waterway to the Regulators by means of lift Bridges.

It is probable that a very few junction Roads between the principal markets may be made at a future time.

As regards Gharbiyah, the preparation of the Road estimates was stopped by the departure of Mr. Willcocks and Mr. F. Roux for Nubia to study the Reservoir question.

In the "Birriyah" or l[illegible] bordering the Northern Lakes.

the Railway Administration had prepared a project for several Branch lines. Mr. Willcocks who has great personal knowledge of the "Berriyah", proposed to make the great escape Canals navigable by Locks and thus bring the produce up to a higher contour along which the present lines of Railway run. This is better fitted for the habits of the people. Hence instead of the Railway, a series of 4 locks have been sanctioned and the estimates got ready for commencement in 1891.

Mr. Garstin on Roads in 1st Circle.

162. — The following is extracted from Mr. W. E. Garstin Report on Roads and is a complete résumé of progress and statistics connected with Roads : —

The agricultural Roads were commenced in the provinces of Sharkiyah and Dakahlia in the beginning of 1890 and entirely completed with the exception of two works (which will be detailed later) by August of the same year.

Funds voted and collected.

163. — The sums voted in the two Mudiriyahs at the provincial Councils were : —

Sharkiyah..............	L.E.	9,753
Dakahliyah.............	L.E.	10,441
Total	L.E.	20,194

Of the above, the amounts actually collected were: —

Sharkiyah..............	L.E.	9,413
Dakahliyah	L.E.	10,295
Total	L.E.	19,708

The balances were found by the Mudirs impossible to collect, partly owing to the poverty of the people in certain parts and partly owing to a certain amount of cultivated land which had been included in the area taxed for the Roads was afterwards found to be "Tawalif".

Length of Roads.

164. — The total lengths of Roads made were 208 kilometres.

Of these 110 kilom. are in Sharkiyah.
98 Ditto Dakahliyah.
Total 208

Masonry Works.

165 — In Sharkiyah Province, there have been made 21 bridges for the Roads alone, while one more is in construction on the Bahr Mues and a

Ferry on Bahr Faqus. This makes 24 in all, two of which are of iron and the rest of wood.

In addition to the above. 14 Canal Heads and Regulators have been bridged for the purpose of these roads. making 38 bridges in all.

These bridges were all of one type. except three: A four metre Roadway has been given and they are all upon wooden trestles. The three exceptions are: an iron bridge over the Mashtul Canal, an iron lift bridge at present under construction on Bahr Mues at Hehya. and a Ferry on the Bahr Faqus. This latter consists of a masonry platform sloping to the water on each side, while two boats have been lashed together and a large timber platform built upon them capable of carrying three or four carts. These are hauled across from platform to platform by means of a chain that lies on the bottom of the Canal. The Bahr Mues bridge is iron as to its construction, all except the piles that carry the lifting gear which are of oak.

In Dakahliyah Province, there have been made 29 bridges for the Roads alone and one Regulator Diarb-en-Nigm has been bridged for this purpose, making a total of 30 bridges in all.

They are all, with the exception of three, and the Diarb Bridge, of wood of the same pattern as those in Sharkiyah.

The exceptions are Sahel draw bridge, Mansurah lift bridge, and Hammama bridge.

The latter is an iron girder bridge with a planked Roadway.

The two former are made entirely of old rails.

Screw heads were fitted on to these and they were sunk in the ordinary way by means of a capstan.

This answered capitally and they have remained as firm as possible. At the same time, if we make any more, I do not propose to use old rails again. It is, I think, false economy. Their section is not at all fitted for bending and jointing as required, their weight is very great and they never make a really neat job. It will be far better to use regular sections of iron either T or angle, and for the piers get out small screw piles from Europe.

I do not believe in the end that these will be dearer than the old rails, and they will be much more fitted for the purpose.

Where lift bridges are not required I think the "Eiffel" pattern will be the cheapest and best, substituting rivets for bolts on account of the propensity of the Fellah to steal all iron he can from bridges of the sort.

Irrigation outlets.

166. — The irrigation outlets were of various kinds; iron pipes, native clay pipes, English fire clay pipes, and brick culverts.

I have come to the most unhesitating conclusion that the latter are the best and in the end the cheapest. The fire clay pipes are very good, but the breakage is awful, something like 50 per cent, and even when put down the Fellahin break them when clearing them out. You can make brick culverts of Arab bricks in lime for from 175 P.E. to 200 P.E. each:

these will last for ever practically. The fire clay pipes cost about 150 P•E. per outlet with carriage and do not last as long.

167. — We made this everywhere from 0.40 to 0.50 high. The latter is the better height and it must then be rolled with heavy iron rollers. The earth should be taken from borrow pits at the side; these, the people fill in at once and no harm is done. Earthwork on Roads.

We learnt also by experience that it is a mistake to make a road on a Canal bank where this can be avoided; it cuts away into dust in no time, while on the natural ground it does not

168. — The whole of these roads have been provided with iron kilometres posts, with the figures from and to each place painted on in Arabic characters. Sign posts have also been put up at every cross road. Distance posts.

169. — We planted trees, some 10,000 in all along several of these roads at 10 metres distance. Here the mischievous propensities of the Fellah worked against us, for the people broke down and pulled up nearly the whole of them. Tree planting.

170. — The expenditure on the roads from the tax raised from the people, was as follows: — Actual expenditure.

Sharkiya.

Earthwork	L.E.	4,698
Bridges	,,	814
Pipes	,,	1,103
Land	,,	1,177
Total	L.E.	7,792

Dakahlia.

Earthwork	L.E,	4,059
Bridges	,,	2,054
Pipes	,,	717
Land	,,	2,049
Large pipes for syphons.	,,	243
Total	L.E.	9,122

171. — In the tracts above Asyut where the basin system exists with its large banks and cross banks and great Canals Roads in Upper Egypt.

with their spoil banks many metres wide, it would seem at first sight that the facilities for getting about would be very great.

Unfortunately this part of Egypt is more difficult to traverse than any other. The banks are very tortuous and money has never been forthcoming to straighten them. In the Nile time after September 15th, the banks both longitudinal and transverse are cut to escape the excess water, and up to November, there exist impassable holes eroded by the escaping water.

The great increase of Regulating Bridges from the Sharaqi Loan will much diminish these difficulties.

As regards the Canals, even where their spoil banks have been primarily made into level roads 8 to 10 metres broad, I am sorry to say that these magnificent banks are wholly useless as roads. The people have a habit consecrated by usage *into a right* of cutting the banks, the moment the Nile Flood retires and of making "Shaduf" wells in the Canal themselves. When the water retires altogether, they dig wells in the canal bed and continue to lift water and pass it through the slits in the bank onto their fields. The result is that the Canal spoil banks which are not less than 3 to 4 metres above ground level are slit up into steep ravines at every 100 metres or so. The only remedy for this is to accept the fact of irrigation by "Shadufs" and give each cultivator a 15 inch glazed clay pipe. This would be put in about 60 centimetres below ground level and the bank made up over it to a 5 metre width. In the Nile time, the pipe would flow free and serve as a water-course head. In the winter and summer, the "Shaduf" could throw its water into the pipe. Nothing smaller than a 15 inch pipe will do.

Pipes for outlets. 172. — For a preliminary experiment, I have ordered from Glasgow L. 100 worth of pipes. Previous experiments with glazed pipes have been very unsuccessful, owing to breakage in transit, and Italian pipes are far too expensive.

I fear it is impossible to make them in this country, as, although at Kena, where the art of burning clay has been successfully practised from time immemorial, the outturn is very thin porous ware, and I fear all the inherited skill in burning without coal would not be available for turning out a thick glazed drain pipe. Up to the present, the Alexandrian Market has not succeeded in selling glazed pipes 12 inches diameter at less than ten shillings a yard, a price far too high.

The question of selling these pipes to the people and inserting them and issuing pipes to replace breakages needs a great deal of management, and it will be necessary, I think, to enlist the Mudirs aid. Once the pipes are inserted, we can proceed criminally against the person who cuts the bank. As there has been a considerable reduction of revenue made in Kena and the Frontier Mudiriyahs, I think the present an excellent opportunity to begin the sale of pipes to the cultivators. One thing is certain that the ordinary native pipe will not do and that the diameter must not be less than 15 inches.

CHAPTER XIV.

Asyut-Girga Railway.

Preliminary Surveys.

173. — The Asyut-Girga Railway was commenced in the latter part of 1889, by sending up a staff of Railway surveyors under Mr. Pitet to set out the line. The main features of the aligument had been previously agreed upon between the Chief Engineer of the Railway Administration and the Inspector General of Irrigation.

In the summer of 1889, Mr. Pitet had made a most detailed study of the longitudinal banks of the two great basins south of Asyut (the Zannar and Beni-Smiâ). In these basins, the waves are enormous and exceedingly destructive to earthen banks. For this reason, the banks had been revetted with masonry walls in former days throughout their length of about 30 kilometres. This revetment was done by the Mudiriyah with probably Corvee labor, the people supplying the materials and carriage.

The result of Mr. Pitet's study was to show that the old banks were far too crooked to admit of a line of Railway.

Final alignment. 174. — The alignment finally resolved upon was to pass through the basins keeping near their higher edge at about a kilometre from the Nile bank, so as to permit of a series of "Nabari" lands between the Railway and the Nile. A line thus carried out passes close to all the large villages on the Nile "Sahil". After reaching Tahta, the line makes for the Tahta Canal on whose bank it goes to Suhag, passing between the river and the town, so as to admit of a good's station on the River. It then makes for the Girgawiyah Canal on whose banks it is carried to near Girga. The prolongation to Kena will probably be up the Zarzuriyah Canal and along the Rashwaniyah Canal.

Utilization of the Railway borrow pits. 175. — Owing to the Line of Railway interfering so much with the delivery of the basin water, it was found advisable to utilize the borrow pits as Canals as much as possible. The serious deterioration of the western Sahil of Gizah caused by the Railway cutting off direct access to the Nile, made the irrigation officers keenly alive to the necessity of so arranging the borrow pits and culverts of the Railway that the Country should benefit rather than be injured by the advent of the Railway. The extensive re-arrangement of the red water Canals contemplated in the Anti-Sharaqi Projects could be made out of the borrow pits and thus much money could be saved by having a combined Canal and Railway.

Earthwork. 176. — it was also found necessary to make over the earthwork to the Irrigation Branch, as the levels and profiles of the canalized borrow pits were very intricate. Also as the incidence of so much extra earthwork might disturb the ordinary repairs of the Irrigation works, it was ruled that the Markaz contractors of earthwork should take the Railway bank along with their ordinary work.

[illegible] 177. — Mr Pitet started with a large staff of men and much "material" for alignment and commenced a most thorough setting out of the Line from Asyut towards Girga. The great intricacy of this alignment which was absolutely final consumed much time, and although Mr. Pitet laboured very earnestly, it was soon seen that he would not finish the alignment in time to allow of setting in hand the most necessary parts of the earthwork of the Railway from the irrigation point of view.

He was asked to abandon this precise style of alignment and give disconnected aligments in those parts most necessary for irrigation progress. This he declined to do and the result was much friction. Finally Mr. Pitet fell ill from over exertion and had to leave.

178. — It was then decided to employ an experienced Railway Engineer under the Inspector General of Irrigation who would direct all the work both masonry and earthwork, and Mr. G. W. Floyer, an engineer of considerable experience in Ceylon and Brazil, was appointed. He worked well and very pluckily all through the hot weather, though his health was very bad, and I regret to say, died at his post in August, just after the works were stopped by the Rising Nile. New personnel.

The work was not resumed until December, when Mr. H. G. Sheppard was sent up with three young untrained European assistants, in addition to the young Greek engineer of Mr. Floyer's staff.

Mr. Sheppard has had much experience in India. He also was employed by the Abukir Reclamation Co. to lay out their drainage channels, etc., etc. He had therefore considerable experience in Egypt, before commencing this work.

179. — The levelling for a Railway passing through basins is of so special a nature, that the ordinary Railway leveller like Mr. Pitet could not be got to attend to the necessary instructions. The data of the Basin are: Full irrigation (Tamam er Rayy), and the Flood of the basin, i. e. the level to which the basin rises in spite of the efforts of the Engineers to keep it down in high Niles or breaches of the systems further south. **Special nature of levelling.**

These vary much from each other in different basins. Their levels are known by their relations to the piers of the basin's outlet Bridges, either onto the Nile, or the next basin, and are spoken of in terms of their supposed height above sea level. The Irrigation Engineers use the sea reduced level as their datum, but never lay the top of a bank to a given reduced level, unless they take the accepted value of the outlet Bridge pier, etc., as their datum. They then know that of the pier top was say 0.20 above the Flood level, their bank should be 0.80 above the Bench Mark of the Bridge (as all banks are put 1.00 above Floods).

If then there is a cumulative error in the levelling from Alexandria of even 10 metres, there is nothing wrong in the bank repairs, as the level of bank top though assumed to be so much above sea level, is really put above the local Bench Mark, the height necessary to give the top of the Bank one metre above Flood.

Mr. Pitet, I regret to say, disregarded the clearest injunctions in this matter and would insist in considering his levels correct and disregarding the local bench Marks which were supplied to him all up the line.

Data for adjustment of levelling.

The levelling of the Railway therefore has been carried on by basins. The Irrigation Bench Mark has been accepted and the Railway Bank made 1.20 above the given Flood value of the basin. If, in the traverse through the basin, an error of say 0.20 in 25 kilometres is found on arriving at the next series, the 0.20 in thrown out and the new series is taken up. The error of 0.20 disappears in the incline up to the next basin which will be either 0.20 steeper or flatter than designed.

It is a well known fact in Egypt that no leveller ever comes nearer than 20 centimetres of his predecessor's result in a distance of 50 kilometres.

It will be readily seen that for the future, if the Railway wish to maintain touch with the Flood levels, they must continue to use the results of the Irrigation officer's observations on the basin Bridges, refering their formation level above the great plane of the basin surface to the local Bench Marks on which the Flood observations are maintained.

180. — Owing to unfortunate delays and vascillation on the part of the agents of MM. Suarès and Co., no great progress was made in the all important point of brick manufacture. The excuse was put forward of not knowing the site of a bridge to the exact centimetre. It was forgotten that bricks in the Nile valley are very seldom made at the sites in a basin, owing to the non-existence of proper earth. The result is, as was foreseen by the Irrigation officers, that there has been a failure of supply of bricks all along the line except in Messrs Sinnott's section. **Delays in brick making.**

The sites of the Bridges were all fixed before the rise of the Nile, so that much local boating could have been done, had the materials been ready.

181. — The Masonry Contractors of the Line are: — **Contractors.**

1st Section Messrs Brouard and Oziol;
2nd » Mustapha Mahdi;
3rd » Muhamed Shafai and Co.;
4th » Messrs Sinnott Bros.

182. The collection of materials in the 1st section is very backward, but in June 1890, work was begun on bridge b', the viaduct of 3 spans of 40 metres across the outlet of the Beni-Smià Basin. The foundations were got in. **Progress in 1890.**

Materials are also very backward in the 3rd section.

The Line will be finished, if there is no break down in the collection of materials, in June 1892.

183. — The following table shows the earthwork executed up to the rising of the Nile in August 1890: — **Detail of Earthwork 1890.**

CUBES	DESCRIPTION OF WORK	RATE	EXPENDITURE
	Tima District.		
162,493	From where Ry line cuts Shaturah to Sal Tema	1 14/40	2,193.655
40,360	From above to Salibet Kom Badr.................	1 14/40	544.860
22,636	Extra excavation to make up bank of Shaturah...	1 14/40	305.586
	Tahta.		
88,426	Gisr Sahil Tahta to Salibet Banaga................	1 13/40	1,171.644
156,473	From junction of Qaw Canal to Salibet Tahta . ..	1 13/40	2,673.267
...	Allowance for extra lead.........................	..	31.031
	Suhag.		
40,000	Bank along Beni-Hilal Canal......................	1 10/40	500.000
	Manshiyah.		
309,229	From 339 m. S. of Manshiyah Bridge to Bridge j...	1 20/40	4,638.435
19,307	Bridge j. to Suhag Bank..........................	1 20/40	289.605
	Girga.		
36,851	Along Girgawiyah Canal....	1 7/40	433.000
...	Balance on Asyut earthwork......................	..	80.388
875,775			**12,261.471**
	Hod Zannar.		
305,549	From Borrow pits.................................	1 14/40	4,124.910
	Hod Beni-Smia.		
263,578	From Canal under 30 m. lead	1 12/40	3,426.514
18,525	» » over » lead................. ..	1 14/40	250.087
	Hod El-Duer.		
192,655	From Canal under 30 m. lead.....................	1 12/40	2,504.515
9,262	» » over » »	1 14/40	125.037
3,031	» Borrow pits under 30 m. lead...............	1 12/40	39.403
735	» » » over » »	1 14/40	9.922
793,335			10,480.388
	Paid for by Girga Directorate....		80.388
1,669,110 m³			
			10,400. —
	TOTAL 90 Expenditure L.E....		**22,661.471**

CHAPTER XV.

Improvements.

Distribution of Loan.

184. — A Loan of L.E. 910,000 has been allotted to Public Works, of which L.E. 800,000 is to be spent in 1890 and 1891.

The greater part of the Loan is devoted to works in Upper and Middle Egypt to prevent Sharaqi and works in the "Sefi" tracts of Middle Egypt and in the Delta to improve Drainage.

A sum of L.E. 45,000 however was devoted to the deepening of the Rayyah Beherah, and it is proposed to devote the sum of L.E. 23,400 for masonry and L.E. 30,000 for earthwork to the rectification of the Khatatbah.

Rectification of Khatatbah Canal.

185. — This very important scheme for the amelioration of the delivery of water in the Beherah Province was submitted by Mr. Foster in approximate detail. This consists in prolonging the Khatatbah Canal on the "Sahil" or strip of high land bordering the Nile to the Mahmudiyah Canal. By this means that portion of the Canal which traverses the depression between the Nile and Damanhour will be abandoned and the Mahmudiyah fed by the water from the Rayyah Behera which now flows into the Khatatbah Canal.

Much benefit will arise from the abandonment of this high level line.

The cost is divided as follows: —

YEARS	CORVEE RELIEF			ORIGINAL WORKS	
	ORDINARY REPAIRS	DREDGING RAYYAH	SPECIAL KHATATBAH	GENERAL IN PROVINCE	SPECIAL KHATATBAH
1891	30,000	20,000	10,000	5,000	4,000
1892	30,000	20,000	10,000	5,000	8,000
1893	30,000	20,000	10,000	5,000	11,400
			30,000		23,400

The above shows the division of the ordinary and special Funds available in 3 years. By this method of spreading the Funds necessary over 3 years, the changes in the system are carried out gradually and definite measures can be adopted.

The result of these changes will be very great and in the future much amelioration of waterlogged land will take place. The Nile flood Irrigation must be effected in the future by the Kafr-el-Eiss feeder instead of by the expensive process of opening the Mahmudiyah Canal Lock gates at Atfeh to feed the Canal in early Nile, a process which brings in much silt which is difficult to remove before November, the time for moving the gunnel cotton to the seaboard.

Future improvements.

186. — As in the Report of 1889, the following improvements still are necessary: —

1) Completion of the Middle-Egypt basin Regulators.

2) Completion of the red water Canals of the Ibrahimiyah system both from the Nile and from the Ibrahimiyah.

3) Installation of Pumps for summer and winter irrigation in Eastern Gizah.

4) Escapes and extension of summer irrigation in Kaliubiyah.

5) Regulators and locks in the Northern Delta. Projects have been submitted for these.

6) Colmotage Works in the low lands of the Delta.

7) Reservoirs in the low lands of the Delta.

Of these 7 heads, only the 5th has taken shape in 1890. Before we proceed with these improvements, it will be necessary to wait until the Sharaqi and Drainage Works have been fully studied, so that it may be clearly seen what money remains available.

CHAPTER XVI.

Barrage Repairs. — Working Season 1890.

Barrage Repairs.

187. — The following notes are abredged from Mr. Liernur's Report.

The work that remained to be done in the winter of 1890 was the completion of the Left half of the Damietta Barrage.

In this portion, there were 30 arches untouched, but it was resolved to permanently close the ten western arches so as to prevent the necessity of regulating on them. This involved the closing of the western lock also.

This closure was effected by a revetment wall joined on to the pier of the 11th arch from the west Bank which was thickened and prolonged 20 metres downstream. The wall is 3.30 metres at base and one metre at top with a batter of $\frac{1}{12}$ on the riverside. A toe of 5 metres wide and 0.75 thick is given at a reduced level of 9.50 and the top of the wall is at 19 00. Its length is 120 metres. The foundations are on wells 3 metres deep.

The earthern coffer dam was begun on January 10th and finished up to R. L. 14.50 upstream on February 7th. The earth was brought from the island and from the Rayyah Taufiqi head. By February 26th, the old floor was thoroughly cleaned and pitched over and concreted and the springs stopped. The old piles at the ends of the floor were sawn off to R. L. 8.00 and the new masonry floor in extension of the old one was in full progress. A very serious spring was met with in bay 17 which had to be most carefully plugged with cement. This spring was then covered with masonry and then the Trieste stone was laid on it uniform with the rest of the Barrage floor.

The extension of the floor was as usual of rubble masonry in cement, great care being taken to make the join on to the old work perfect. The bays N^{os} 20, 21, 22, 23 were much scoured upstream and concrete had to be lowered in skips to make a foundation on which the floor was eventually laid.

The line of old piles downstream proved very troublesome, as between them there were innumerable springs, all of which had to be closed by passing them through pipes and building round the pipe. In the bays 21 - 30 (old numbers), owing to the very insecure and treacherous subsoil, the new floors were raised to 10.00 with slopes on either side down to the level of the rest of the Barrage. The work progressed well without any accident until March 25th. On the night of March 25th-26th, a spring broken out at the edge of the upstream apron of the work of season 1888 and though insignificant at first, it gradually gained on the engines and it was found necessary to abandon the works at 2 a. m. It was found that there existed a free communication diagonally under the Floor of 1888 from the river under the " sadd ". Early on the morning of the 26th, the " sadd " sank 1 $\frac{1}{2}$ metres, clearly proving the passage of water under it and in contact wits the earth.

It was afterwards found that the spring had gradually removed the earth from under the apron of 1888 and that the apron broke by the weight of the " sadd ", thus causing the " sadd " suddenly to sink alarmingly. The crack in the floor apron extended from bay 40 to bay 34 where it was only 15 metres from the cut water.

It was in this length in 1888 that the floor had to be laid on an old stratum of lumps of half set mortar and concrete metal left there by the original Barrage builders.

A long "sadd" was made, extending parallel to the Barrage to bay 44. The closure was made on April 14th, and on April 16th work was again started inside the old " sadd ". Between the old and new " sadd " was maintained to minimize the strain.

The greatest precautions were taken to keep the arches closed in which no work was going on in case of a sudden breach of the "sadd". The last floor stone of the Barrage was laid on May 26th. The broken floor which had sunk was covered with masonry up to R. L. 9.50. It was found that in front of ten arches the upstream floor had broken off clean and sunk 1.50 at the deepest part, and the whole mass was much fissured, and in each crack a spring issued. These were all closed with great difficulty, but now this portion is of great thickness and very strong. The difficulties in meeting the effects of this accident were very great indeed and caused much anxiety.

The last part of the masonry under water level was finished on June 16th, and on July 10th, the sadds were cut.

The work done at the Barrage in 1890 was.

2,770	m^3	Masonry demolition.
7,600	»	Concrete.
13,060	»	Rubble stone masonry.
2,000	»	Brickwork.
930	»	Old Cairo Ashlar stone.
290	»	Trieste Ashlar stone.
25,460	»	Dry Rubble pitching.

In all 198,988 labourers were employed on daily wage exclusive of those employed by the Contractors.

The cost of repair to the Barrage is about L.E. 3,180 per arch.

After Mr. Reid's departure for India, Mr. G. Liernur, the Chief Engineer under him was appointed to the charge of the regulation of the Barrage.

CHAPTER XVII.

Personnel.

Col. J. H. Western, C. M. G., left the Public Works service early in the year and took up work in London for the Egyptian Railway Administration.

Mr. A. G. Reid, on the completion of the Barrage in July, left for India and the Barrage establishment was broken up.

Both these officers have conferred a great and lasting benefit on Egypt by their successful efforts in repairing the Barrage. They raised the standard of masonry in the Delta and trained a number of useful subordinates.

The Inspectors of Irrigation ,

Mr. W. E. Garstin, 1st Circle.
Mr. W. Willcocks, 2nd Circle.
Mr. E. W. P. Foster, 3rd Circle.
Major R. H. Brown, 4th Circle.
Abu-Saud Bey, 5th Circle.

have had their hands fully occupied by works and in the distribution of water. Their work has been at very high pressure and they have not failed to cope with it. In the four Circles that have summer Irrigation, the skill with which the distribution was arranged, was very conspicuous, and, as I said before, the working of all the Irrigation depends on them.

Among the Directors of Works,

Mr. W. Marshall Hewat has done good work in the direction of the works at Qushesha Escape. He has maintained a good standard of masonry.

Mr. Allan J. Joseph has again done well in directing and carrying out a very large amount of original work in the Northern part of Kena and in Girga Province. He also had the ordinary work of the Mudiriyah in charge. His grasp of office work has greatly improved.

Mr. Arnold H. Perry has done the very greatest service to Government in his very intelligent direction of the steamer service. He has also brought order out of chaos in the Government property at

Gizah and brought many abuses to light. The economy of the steamer service is very marked.

Mr. George Liernur has had charge of the Barrage, since Mr. Reid left and has done his duties carefully.

Mr. F. Roux has done very good work in the 2nd Circle and deserves credit for the assistance he has given to Mr. Willcocks in Nubia.

Mr. Langley and Mr. Courtenay Clifton have both worked well as Assistant Inspectors in the 1st and 2nd Circles respectively.

Ismaïl Bey Sirri has done good work as Assistant Inspector 4th Circle and held charge of the Circle during the Nile.

After the Barrage was completed 6 young Englishmen and 8 Arab Engineers of Assistant's grade were selected to fill the appointments of Surveyor of Contracts. It was found that the existing staff could not, when occupied with current work, take sufficient measures to check contract measurements. The abolition of the Corvee having rendered work by contract universal, the work of surveillance and measurement was enormously increased. The staff took up their duties late in the year.

Among the Chief Engineers specially deserving of notice are : —

1st Circle.

Muhamed Bey Sabri, Ahmed Bey Said have both kept up their reputation.

Ali Effendi Naggâr of Kaliubiyah has worked hard in his small province.

2nd Circle.

Mr. St. John Ker is specially mentioned for his business like habits.

The Chief Engineers of Gharbiyah, Mohamed Effendi Talâat and Hassan Effendi Sherif, are both spoken of highly as Irrigation Officers.

3rd Circle.

Abdul-Wahab Bey Zaki has specially distinguished himself in the carrying out the very difficult repair of the Rayyah Behera Head and in his intelligent direction of the work of planting out the slopes of the Rayyah. The great success obtained in reforming the regime of the Rayyah is largely due to his intelligent working under Mr. Foster's direction.

Musa Bey Ghalib of Gizah has much improved in his general grasp of work this year.

4th Circle.

Muhammed Bey Nagib of Minya has done extremely good work and was specially recommended for promotion, but the step went by seniority.

Ali Effendi Burhan has been most active in his work in the Fayum and has displayed a zeal that is beyond praise. His health has been affected by his strenuous efforts to better distribution in the Fayum.

Hassan Effendi Wasfi of Beni-Suef works quickly and well.

5th Circle.

Abu-Taleb Effendi Gad, the Chief Engineer of Kena, has done good work.

On Roads, Mr. P. Brown has done very good work in getting matters pushed on.

Mr. W. O. Joseph and Mr. P. Chapman did good work at the Barrage and have taken up their new duties.

Mr. P. G. Wakefield was employed in masonry surveillance at a very isolated spot in Kena Gebel Tarif. He worked well and has a good manner with natives.

Mr. Mc Killop did good work in Beherah, being active and energetic.

Among the Arab Surveyors of Contracts,

Hassan Eff. Raghib, 1st Circle.
Muhamed Eff. Fahmi, 2nd Circle.
Muhamed Eff. Mungi, 2nd Circle,
Mahmud Eff. Rifqi, 3rd Circle.
Hassan Eff. Hidayat, 4th Circle.
Muhamed Eff. Labib, 4th Circle

have come out prominently.

Among the Assistant Engineers, the following are deserving of notice: —

1st Circle.

Ahmed Helmi, Hassan Wasif, Ali Taleb, Muhamed Naim, Abder-Rahman Sami, Muhamed Nabih, Muhamed Shafiq.

2nd Circle.

Mohamed Muhib, Abder-Rahman Rushdi, Abdallah Hasib, Hassan Kamil, Mahmud Fahmi, Ahmed Ramzi, Ahmed Sabri, Ahmed Negib, Mohamed Afifi.

3rd Circle.

Ahmed Hamdi.

4th Circle.

Mohamed Husni, Abder-Rahman Wahbi, Mohamed Wafai.

Girga.

Abdallah Wahbi, Yusif Sidky.

5th Circle.

Muhamed Enayat, Ali Lutfi.

Inspection General.

The Engineers of the surveying and levelling staff have done well in Kena and Girga, viz: —

Ahmed Rustum, Mohamed Shukri, Mohamed Mamun, and Ahmed Shafiq in Beherah under the 3rd Circle.

Ali Subki has developed in to a good reconnaissance surveyor. Ahmed Mikawi and Shahatah Nasrat have much improved in their work.

Ibrahim Effendi Helmi, attached to Inspector General, has worked most conscientiously and hard.

Accountants.

The duties of this important post have been performed by Syrians and foreigners. The native Egyptian is apparently not yet educated up to this standard. Though not originally intended to be head clerks also, the office has practically become head clerk and accountant combined.

The three best are: —

Aziz Abu-Shaar, of the 3rd Circle.
Joseph Mattoura, of the 4th Circle.
Michel Zananiri, of the 2nd Circle.

Mr. J. Hanki has done very well in the Inspector General's office in the work connected with Sharaqi works.

Draughtsmen.

188. — The draughtsmen attached to the Circles are of very inequal calibre. Some can barely draw from a sketch, others can design from rough data merely. The result is that the designs are most imperfect in some Circles, and this state of things cannot be rectified until the posts are filled by trained Engineer-draughtsmen. There is a possibility of getting what we want from the Jesuit and other European schools in Cairo, but it is against the feelings of the Egyptians and I fear the " technique " must suffer.

Native Engineers.

189. — Mr. Garstin, I am glad to say, sees a distinct change for the better in the native Engineers: Mr. Willcocks very strong personal rule tends to the excessive elevation of a very few and the degradation of the rest to a common mean level: Mr. Foster almost despairs of any elevation of the engineers under him, finding that they never exercise either observation or thought: Major Brown finds that with constant direction, the excessive tendency to commit errors can be overcome: Mr. Joseph finds that the district Engineers can improve in Girga.

Under Abu-Saud Bey, too little is entrusted to the District Engineers and in fact, it is to be feared that the 5th Circle is regarded as a sort of Siberia by the Arab Engineers. Two Engineers have resigned this year rather than go to Kena.

J. C Ross, Lieut.-Col.
Inspector General of Irrigation.

APPENDICES.

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I. — The Million Fund augmented by a special credit of L.E. 139.358.

NAME OF WORKS	OUTLAY IN 1889		OUTLAY PREVIOUS TO 1ST JANUARY 1889		SPECIAL GRANT IN 1890		GRAND TOTAL	
	L.E.	M.	L.E.	M.	L.E.	M.	L.E.	M.
Establishment, T. A., etc.	11,953	220	50,976	087	5,597	039	68.526	346
Rosetta Branch	72,525	770	133,365	621	14,415	012	220.306	403
Damietta Branch	14,222	240	108,440	603	78,806	882	201.469	725
Rayyah Taufiqi								
Excavation	1,680	561	204,023	707	..	..	205.760	808
Land	26	579	22,476	580	..	..	22,503	159
Barrage station	298	416	1,166	316	..	..	1,464	732
Head works	22,441	300	27,966	499	..	..	51,664	030
Two syphons	1,446	331	8,139	442	18,986	109	28,571	882
Two regulators	..	..	3,465	838	..	..	3,465	838
Two R'way Bridges	3,848	236	13,073	022	..	..	16,921	258
Water course syphon	..	..	1,121	578	..	..	1,121	578
Bahr Moez Head	12,050	341	15,528	000	..	..	27,578	341
Gangara Works	10,334	842	8,076	000	..	.	18,410	842
Mit Ghamr Lock and 2 regulators	..	..	25,093	001	3,366	000	28.459	001
Mansurah swing Bridge	..	..	1,986	540	..	..	1,986	540
Kafr Badamas lift Bridge	124	375	309	000	..	..	433	375
Lock into Nile Mansurah	12	491	23,534	400	..	..	23,546	891
Kolangil lock and 2 regulators	..	..	17,474	548	..	..	17,474	548
Ananir syphon	..	..	1,225	210	..	..	1,225	210
Damietta reservoir	..	..	11,535	480	..	..	11,535	480
Two drainage projects	..	..	10,908	670	..	..	10,908	670
Towcher project	..	..	1,000	000	.	..	1,000	000
Rayyah Menufiyah lock	..	..	17,608	791	..	..	17.608	791
Baguriyah Head lock	..	..	13,562	399	..	..	13,562	399
Shubrabas lock	..	..	12,191	141	..	..	12,191	141
Dalgamun swing Bridge	..	..	3,197	570	3,000	000	6,197	570
Lock into Nile Kodabah	39	061	8,445	215	8,415	945	16,900	221
Santa lock	..	..	7,598	190	3,059	505	10,657	775
Santa swing Bridge	800	875	3,142	043	..	..	3.942	918
Bahr Saidi reclamation	..	..	9,170	815	..	..	9,170	815
Mahmudiyah syphon	..	..	3,654	094	..	..	3,654	094
Kafr Dawar lock	1	940	12,301	883	..	..	12.303	823
Sanil Markaz	..	..	236	980	..	..	236	980
Rosetta Canal	..	..	25,021	708	..	..	25,021	708
Feshn syphon and work	32	536	18,065	102	..	..	18,097	638
Wadi Rayyan	..	..	1,263	998	..	..	1,263	998
Hod El-Tuyur	..	..	4,503	546	..	..	4,503	546
Bahr Wardan	..	..	259	899	..	..	259	899
Gharaq (Fayum)	..	..	1,061	964	..	..	1,061	964
Tools and plant	1,717	—	14,280	536	..	..	15,997	536
Sharaqi	..	..	..	..	2,688	174	2,688	174
Petroleum deposit	..	..	..	..	89	680	89	680
Balance on Million	..	..	..	..	1	870	1	870
TOTALS	158,546	114	846,852	016	138,344	746	1,138.342	876

II. — Ordinary Budget.

N°	DESCRIPTION OF WORK	TOTAL ON EACH WORK	TOTAL IN PROVINCE	TOTAL IN CIRCLE
	Original Works.			
	Kaliubiyah			
1	Pipe for Mursafawiyah Canal...............	265	265	
	Sharkiyah			
2	Regulators Fatimet Farsis Canal............	464		
3	do. do. Muqaffif Canal	536		
4	Road Bridges..............................	905	1,905	
	Dakahliyah			
5	Sahil Canal: two heads on Effendiyah and Khazzan Ghedid Canals....................	797		
6	Buhiyah Canal: two heads on Shaallah and Dibigiyah Canals..	957		
7	Bahr Sait: Diarb En-Nigm Regulator........	1,137		
8	Inspection house at Regulator...............	130		
9	Bahr Saghir: two heads in Nazl and Abd-er-Rahman	437		
10	Sharqawiya Faraskur: Kibirah syphon......	874		
11	do. do. Higagah syphon.....	776		
12	do. do. 6 pipe heads.........	379		
13	do. do. 20 Timber bridges...	285		
14	do. do. land on extension to Ez: El Borg	763		
15	Manshuriyah Canal: Raising bed and stone dams....................................	1,266		
16	Manshuriyah Canal: Extra work in Qalaugil Regulator................................	396		
17	Manshuriyah Canal: Bricks stored at Mit-Ghamr....................................	862		
18	Manshuriyah Canal: Road Bridge (Iron Swing Bridge).....	596		
19	Manshuriyah Canal: Sahil Canal Road Bridge	587		
20	Minor Works................................	197		
21	Part of Earthwork Ezzbet-el-Burg Canal.. ..	2,042		
22	do. Sahil Canal Widening.......	1,837	14,318	16,488
	Menufiyah			
23	Petty Works................................	138	138	
	Gharbiyah			
24	Mehallet Roh two syphons..................	170		
25	Bridge Near Kalline........................	1,663		
26	Sundry Works...............................	329	2,162	2,300
	Carried forward.....	....	....	18,788

II. — Ordinary Budget (*Continued*).

N°	Description of Work	Total on Each Work	Total in Province	Total in Circle
	Brought forward.....	....	....	18,788
	Gizah			
27	Sluices for Hod Aquas & Ghamasah Kobrah..	287		
28	Pipes in Ennazah Escape.................. .	398		
			685	
	Beherah			
29	Abu-Ghaleb and Beni Salama Desert basin Regulations..................................	6,538		
30	Khandak Canal Masonry	1,000		
31	East Gannabyah Works.............	525		
32	West do. do.	561		
33	Baslaqun and Sàaraniyah Railway Bridges.	1,417		
34	Kafr Dawar Lock Final payments...........	380		
35	Gediyah and Borg Rashid Head Sluices.....	144		
36	Houses at Kafr Dawar & Kafr-el-Eiss........	238		
37	Bridges for Agricultural Roads...............	233		
38	Distance pillar in various Canals...........	26		
39	Compensation for land Behera.............	540		
			11,630	12,315
	Beni-Suef			
40	Tansa Culvert..............................	211		
41	Genedi Regulator..........................	299		
42	Pipe syphon under Selim Pasha............	659		
43	Qushesha Escape (L. E. 35,330 to Special Budget)..................................	1,952		
			3,121	
	Fayum			
44	Head at Medinah to Talat Canal and 5 Head Sluices at Sheikh-el-Gimal................	1,000		
			1,000	
	Minya			
45	Head & Regulation & Culvert on Safsafa Canal....................................	848		
46	Abu Baqara Canal and Head............. ..	2,615		
47	Masonry Works on Sàadiyah Canal..........	1,258		
48	do. do. Aba Canal...............	1,189		
49	Price of old boilers for pipe drains...........	425		
50	Syphon & Culvert on Abu-Shusha Canal.....	1,533		
			7,868	
	Asyut			
51	Dalgawi Escape (collection of materials).....	3,000		
52	Culvert Hosha El-Tawabiyah...............	262		
			3,262	15,251
			Grand Total L.E.......	46,354

III. — Special Expenditure.

Nubariyah Canal.

OUTLAY				TOTAL
1887	1888	1889	1890	
23,453	45,965	1,920	80	71,418

IV. — Expenditure on Maintenance of Works during 1890.

PROVINCE	PROTECTION AGAINST INUNDATION	REPAIRS TO MASONRY	TEMPORARY DAM IN NILE	CORVÉE ABOLITION	TOTAL
Kalliubiyah	2,408	1,238	....	21,115	24,761
Sharkiyah	....	3,837	....	28,258	32,095
Dakahliyah	7,423	4,756	....	24,051	36,230
Menufiyah	6,201	5,506	....	31,140	42,847
Gharbiyah	4,949	9,882	....	32,499	47,330
Behera	3,983	2,617	3,244	61 809	71,653
Gizah	2,206	1,659	....	7,188	11,053
Beni-Suef	3,962	80	....	17,998	22,040
Miniyah	3,689	....	....	26,993	30,685
Asyut	11,390	2,952	....	57,000	71,342
Fayum	....	1,460	....	11,958	13,418
Kena, Esna	1,607	764	....	42,971	45,342
Girga	973	1,464	....	36,131	38,568
Barrages	7,500	....	....	....	7,500
	55,291	36,215	3,244	399,115	494,845

V. — Earthwork executed in 1890.

PROVINCE	CUBIC METRES		COST	
	BY PROVINCE	BY CIRCLE	BY PROVINCE	BY CIRCLE
Kaliubiyah	772,395	....	21,115	....
Sharkiyah	1,088,093	....	28,258	....
Dakahliyah	1,196,556	3,057,044	21,051	73,424
Menufiyah	991,350	....	30,749	....
Gharbiyah	1,731,422	2,722,772	32,890	63,639
Gizah	421,751	....	7,188	....
Beherah	1,847,860	2,269,611	61,809	68,997
Fayum	856,680	....	11,958	....
Beni-Suef	1,219,324	....	17,998	....
Minyah	1,860,692	....	26,996	....
Asyut	2,597,119	6,533,815	57,000	113,952
Girga	2,362,140	2,362,140	36,131	36,131
Kena and Esna	2,946,997	....	41,812	....
Hudûd	77,267	3,024,264	1,159	42,971
TOTALS		19,969,646		399,115

VI. — Payment to Behera Irrigation Society for supply of water in that Province.

	OUTLAY			
	1890	1889	1888	1887
Fixed annual sum	26,320	26,320	26,320	26,320
Supply of water Atfeh	14,452	14,405	16,159	10,073
» » Khatatba	8,719	19,274	18,776	17,458
Miscellaneous	331	....	....	....
	49,822	59,999	61,255	53,851

VII. — Details for 1890 of cultivated area, paying Land Tax or rented from Government.

NAME OF PROVINCE	AREA CULTIVATED (FEDDANS)			ASSESSMENTS			No. OF PERSONS PAYING LAND TAX	TOTAL POPULATION
	PAYING LAND TAX	RENTED BY GOVERNMENT	**TOTAL**	LAND TAX	RENT BY GOVERNMENT	**TOTAL** L.E.		
Kaliubiyah	186,573	1,292	**187.865**	262,907	2,346	**265.253**	28,883	271,391
Sharkiyah	516,057	5,382	**521.439**	406,373	2,535	**408.908**	42,921	471,139
Dakahliyah	476,970	4,780	**481.750**	498,551	5,156	**503.707**	36,367	588,644
Menufiyah	350,075	2,870	**352.945**	536,766	4,780	**541.546**	83,570	646,013
Gharbiyah	838,605	30,188	**868.793**	900,553	8,400	**908.953**	60,532	936,276
Beherah	532,713	2,953	**535.666**	385,682	3,481	**389.163**	28,535	401,730
Gizah	178,954	9,070	**188.024**	208,343	3,015	**211.358**	31,035	283,833
Fayum	230,556	12,239	**242.795**	131,368	4,360	**135.728**	20,504	228,709
Beni-Suef	234,749	3,947	**238.696**	219,850	3,356	**223.206**	25,075	219,573
Minyah	388,661	3,325	**391.986**	333,363	2,536	**335.899**	42,823	315,803
Asyut	417,201	3,200	**420,401**	510,349	3,930	**516,279**	75,078	563,049
Girga	328,017	5,062	**333,079**	386,110	8,087	**394,197**	58,461	521,413
Kena	339,313	7,520	**346,833**	228,312	8,038	**236.350**	45,416	406,858
(Old Idfu)	20,000	4,000	**24.000**	12,000	2,000	**14.000**	1,000	25,000
Hudûd including Edfu	70,845	7,500	**78.345**	31,021	3,502	**34.523**	117,732	237,961
TOTALS	5,109,289	103,328	**5,212,617**	5,051,548	65,522	**5,119.070**	710,922	6,117,392

The old district of Idfu is assumed at the above figures out of the real total of Hudûd which includes Idfu and Aswân. The Idfu figures only should be added to make a grand total for the provinces under the Irrigation Department.
The above figures are furnished by the Finance Department.

VIII. — Details of expenditure compared with revenue and population in the Circles of Irrigation.

NAME	AREA CULTIVATED FEDDANS	REVENUE	NUMBER OF POPULATION	MAINTENANCE		EARTH-WORK CORVEE FUND	PUMPING WATER	TOTAL	COST PER		
				NILE PROTECTION	MASONRY WORKS				FEDDAN cultivated	POUND OF REVENUE	HEAD OF population
		L.E.		L.E.	L.E.	L.E.	L.E.	L.E.	L.E. M.	L.E. M.	L.E. M.
1st Circle................	1,191,054	1,177,868	1,331,174	9,831	9,831	73,424	....	93,086	0.0781	0.0790	0.0690
2nd Circle................	1,221,738	1,450,499	1,582,289	11,150	15,388	63,639	....	90,177	0.0738	0.0621	0.0569
3rd Circle	723,690	600,521	685,563	6,189	4,276	68,997	49,822	129,284	0.1786	0.2152	0.1885
4th Circle................	1,293,878	1,211,112	1,327,134	19,041	4,492	113,952	....	137,485	0.1061	0.1135	0.1035
Girga	333,079	394,197	521,413	973	1,464	36,131	....	38,568	0.1157	0.0978	0.0739
Kena and Esna............	370,833	250,350	431,858	1,607	764	42,971	....	45,342	0.1222	0.1811	0.1049
Totals.....	5,134,272	5,084,547	5,879,431	48,791	36,215	339,115	49,822	533,942	0.1039	0.1050	0.0907

IX. — Details of maintenance of the Irrigation earthworks by the Corvee Funds for 1890.

Province	Sefi Canals			Nili Canals			Drains			Miscellaneous Cost	Total Length of Canals and Drains	Banks			Total
	Cost	Length Kilom.	Cost p. Kilom.	Cost	Length Kilom.	Cost p. Kilom.	Cost	Length Kilom.	Cost p. Kilom.			Cost	Length Kilom.	Cost p. Kilom.	L.E.
Kaliubiyah	24,447	481	50.82	4,669	588	8.11	Nil	..	..	..	1,069	..	..	..	21,115
Sharkiyah	15,682	1,820	8.06	3,021	600	5 03	5,776	152	38.—	..	2,572	..	..	..	28,258
Dakahliyah	9,934	1,264	7.86	2,638	344	7.66	20,150	349	58.61	..	1,957	..	..	..	21,051
Total 1st Circle	**50,063**	**3,565**	**14.04**	**10,328**	**1532**	**6.74**	**26,226**	**501**	**52.34**	..	**5,598**	..	..	..	**70,424**
Menufiyah	..	615	..	..	837	..	..	..	..	..	1,452	..	..	..	..
Gharbiyah	..	1,901	..	..	340	..	..	475	..	..	2,716	..	..	..	..
Total 2nd Circle	**33,334**	**2,516**	**13.24**	**8,438**	**1177**	**7.16**	**8,064**	**475**	**16.97**	**7,206**	**4,168**	**6,897**	..	..	**63,939**
Behera	20,451	1,081 ½	..	1,189	200 ½	5.93	280	88	3.17	556	1,370	1,393	168	7.93	21,800
Ghizah	37,000	41	..	2,783	290	8.90	..	..	..	933	290	3,472	350	9.92	41,188
Total 3rd Circle	**57,451**	**1,122 ½**	..	**3,972**	**490 ½**	**8.09**	**280**	**88**	**3.17**	**1,489**	**1,660**	**4,865**	**518**	**9.27**	**63,907**
Fayum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	11,058
Beni-Suef	2,000	223	8.96	8,231	81	101.61	..	137	..	830	441	,5937	252	22.07	17,008
Minya	8,200	496	16.53	2,606	72	36.19	..	326	..	2,654	894	13,536	651	20.79	20,000
Asyut	23,397	213	109.84	10,220	237	43.12	..	14	..	10,552	464	12,831	729	17.75	57,000
Total 4th Circle	**33,597**	**932**	**36.04**	**21,057**	**390**	**53.99**	..	**477**	..	**14,036**	**1,799**	**32,304**	**1,632**	**19.55**	**118,982**
Girga	..	..	..	**13,549**	**725**	**18.63**	..	..	..	**3,011**	**725**	**10,871**	**917**	**21.34**	**36,131**
Kena and Esna	..	..	..	**26,290**	..	..	..	..	..	**2,530**	..	**14,101**	..	..	**42,921**

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